

REVIEW

Current perspectives on anabolic steroids

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Abstract

Steroids are used outside the realm of competitive athletics in Australia among a wide variety of groups with different motivations and goals. This paper provides an overview of the reasons for use; rates of usage; physical and psychological side effects; and sources of steroids. Issues associated with injecting steroids; their current legal status; and drug education and prevention programmes are reviewed briefly. Research involving identified sub-populations is needed to determine user profiles and prevalence rates of users and potential users. Studies of Australian users are also needed to obtain baseline information on areas of potential harm associated with steroids use, e.g. aggressive behaviour, needle-sharing behaviour, physical side effects and potential for dependency. It is concluded that future deterrence strategies should focus more on demand reduction, rather than supply. [Beel A, Maycock B, McLean N. Current perspectives on anabolic steroids. *Drug Alcohol Rev* 1998; 17:87–103]

Key words: anabolic steroids, drug education, prevention programmes, harm reduction

Introduction

Over the past three decades the level of anabolic-androgenic steroid use has increased significantly in Australia and overseas [1–4]. The use of performance-enhancing substances, in particular anabolic steroids, has been associated mainly with elite competitive athletes, but there is emerging evidence of use for the enhancement of body image among the

fitness community [5–7], occupational groups [8,9] and the homosexual community [4–11].

In the United States it is estimated that there are more than 1 million current or former anabolic steroids users [12], while in Canada it is estimated that 83 000 young people aged 11–18 years have used anabolic steroids at least once in the past year

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[13]. In 1989 it was conservatively estimated that there were 15 000 users in Australia [2], while the 1995 national household drug survey indicated that 75 000 people has used anabolic steroids for non-medical reasons [14]. There is also evidence that self-reported levels of anabolic steroids use may underestimate actual rates of usage. In a study of competitive athletes in US colleges, for example, the projected rate of use was at least three times larger than self-reported levels [15].

This aims of this paper are to:

- (i) provide an overview of relevant background information including reasons for use; rates of usage; physical and psychological side effects; and sources of anabolic steroids;
- (ii) review several controversial areas including needle-sharing issues and the possibility for the transfer of blood-borne viral infections; legal issues associated with anabolic steroids use; and drug education and prevention programmes; and
- (iii) highlight areas that require further research and policy development.

The potential harm associated with the use of anabolic steroids is wide-ranging involving, for example, needle-sharing behaviour and the risk of transmission of blood-borne viral infections, physical side effects, dependency and aggressive behaviour. Further to this it is suggested that the illegal nature of anabolic steroids use increases the level of harm experienced due to the unsupervised use of anabolic steroids in large doses, commonly of questionable composition. This paper concludes that future deterrence strategies should focus more on demand reduction, rather than supply restriction through detection and enforcement.

Performance-enhancing substances

Performance-enhancing substances have been categorized into six classes of prohibited substances by the International Olympic Committee (IOC): stimulants, narcotic analgesics, anabolic steroids, beta-blockers, diuretics and peptide hormones and analogues [16]. In a survey of IOC accredited laboratories anabolic steroids were the most common class of substances detected; 2.5% of samples tested yielded a positive result and 58% of the positive samples identified anabolic steroids [16]. In Australia between 1% and 2% of drug tests from 1991/

92 to 1994/95 were positive [17], and in 1994/95 28% of the positive tests detected anabolic steroids. While this low rate of positive drug tests among competitive athletes is commendable, there is evidence that these figures may not represent the full picture. It has been reported in the United States that when testing is announced only 2% of athletes test positive, whereas when testing is unannounced (generally out of competition) 50% test positive [3].

Anabolic androgenic steroids pharmacology

Anabolic androgenic steroids are synthetic derivatives of testosterone, the naturally occurring sex steroid hormone. In order to retard the breakdown of testosterone in the liver, the testosterone molecule is modified to delay the rate of absorption and/or catabolism so that effective levels of the steroid are maintained in the systemic circulation for longer periods [18]. The synthetic forms of testosterone are designed to separate and decrease androgenic (which produces male secondary sexual characteristics) effects and increase the anabolic (tissue building) effects. The anabolic effects involve increased nitrogen retention and protein synthesis, while several compounds are thought to have an anti-catabolic effect i.e. blocking the glucocorticosteroid effects of depressing protein synthesis during stressful training, although this mechanism is not fully understood [18].

Anabolic steroids are available in both oral and parenteral (injectable) form. The oral form is modified (generally alkylated at the C17-alpha position) to slow down its inactivation in the liver. The parenteral form is generally an esterified steroid (C17-beta position) with this process making it more fat soluble, resulting in a slow release into circulation and therefore a prolonged action [18]. Modifications of the testosterone ring structure can also enhance the potency of a given steroid or alter its metabolism, in addition to slowing the rate of inactivation in the liver. For a review of the history of synthetic testosterone see Hoberman & Yesalis [19].

Mechanism of action of anabolic steroids

Celotti & Negri Cesi reviewed the effect of anabolic steroids on muscles and their possible mechanism of action [20]. They proposed that exogenous steroids *might*: antagonize the increased protein breakdown

during the muscular stress of athletic training; increase fluid and electrolyte retention, producing an increase in body weight; induce a faster recovery after strenuous exercise as suggested by circulating lactate and creatine kinase levels; and produce psychological effects (increase aggressiveness, euphoria and diminished fatigue) which might facilitate training and help in competitive performance [20].

Anabolic steroids and muscle strength

There is general agreement that anabolic steroids do not enhance the aerobic capacity of athletes [21–24]. In terms of increased muscle size and strength there have been equivocal findings, with consistent improvement only demonstrated in intensively trained weight lifters who were maintaining a high-protein, high-calorie diet [20,22]. It has been suggested by Kennedy that, in some instances, increases in strength are possibly related to placebo effects motivating an enhanced degree of training [25]. Earlier studies have been criticized for having substantial methodological inadequacies with many failing to control for diet, level of weight training experience, training programmes and specificity of testing. Samples were inadequate in several studies (e.g. too small or biased in sampling), while other studies were criticized for incorporating dosage regimes which were too low or too limited in time [20,23]. A double-blind controlled trial involving healthy men found that a high dose of anabolic steroids over 6 weeks increased body weight. Increases in strength were also recorded, but these changes were relatively small and highly variable [26].

A review of the effects of anabolic steroids on muscular strength by Elashoff *et al.* [24] only considered studies that had used a placebo control, had randomly assigned subjects to groups, and reported a percentage change in strength. This review concluded that these drugs may slightly enhance muscle strength in previously trained athletes. It was also noted that research involving low dosages cannot be generalized to athletes taking supra-pharmacological amounts, often involving several different anabolic steroids. Bhasin *et al.* [27] administered supraphysiologic doses of testosterone (600 mg per week) to normal men and found that when combined with strength training fat-free muscle mass, muscle size and strength increased.

Whereas reviews of the scientific literature yield cautious conclusions as to the effects of anabolic

steroid use, anecdotal evidence is much less equivocal. In evidence given to a Canadian inquiry into drugs in sport [3], coaches, athletes and physicians consistently reported that athletes using anabolic steroids were able to train more intensively, recover more efficiently from training and cope better with the pain associated with intensive training. Anabolic steroid use was also thought to increase size and strength and facilitate feelings of confidence, well-being and enthusiasm.

Anecdotal reports of this nature should not be ignored, but caution must be exercised in interpreting conclusions drawn solely from this type of evidence. Conversely, it may be that some of the more tightly controlled trials which have yielded less dramatic effects may have incorporated dosage levels lower than those commonly used, and if so these results may underestimate the effects of these drugs. There is as yet no consensus as to the effects and mechanisms of action of anabolic steroids.

Anabolic substances strategy in Australia

The National Campaign Against Drug Abuse which commenced in 1985, has contributed to the development of drug policy aimed at minimizing the harmful effects of drug use in Australian society. It is a broadly based campaign covering both illicit drugs and legally available substances, but it was not until the most recent evolution of the campaign, the National Drug Strategy (NDS), that the use of prescribed performance-enhancing drugs was included in the Strategic Plan (1993 to 1997) [28].

In conjunction with the NDS Plan the NDS Committee established the Anabolic Substances Sub-Committee in March 1993 to develop a strategy to reduce the harm caused by anabolic substance use. This strategy identified four groups of users and specifically targets the first three: professional and amateur body builders; those employed in certain areas of the security industry such as nightclub bouncers; school-aged youth (ages 12–19) and elite sports athletes.

Sub-populations of users

Anabolic steroids are used by a wide variety of people with different, but sometimes overlapping, motivations and goals. From within an identified group of potential users e.g. body builders or weight trainers, further sub-groups can be identified and

classified [29]. For example, Dillon (1995), identified four sub-groups of users in inner city Sydney gyms [4]: a group who took anabolic steroids for very brief periods associated with particular events (e.g. a dance party); hard-core trainers with little knowledge about anabolic steroids; hard core trainers who believed themselves to be well-educated about anabolic steroids; and a group who continuously took large doses of these drugs as part of competition training and also supplied them to other users [30]. This research revealed that even within a small community, anabolic steroid users vary widely in their knowledge, reasons for use and drug-related behaviour. In addition to the above groups there is evidence of anabolic steroid use to enhance body image by models [9] and members of the homosexual community [10,11,30].

Given the different motivations for using anabolic steroids of different sub-populations, different approaches will need to be considered in formulating prevention and harm minimization strategies.

Reasons for use

Anabolic steroids are used for a wide variety of reasons but which can be subsumed within two factors: improved performance (strength, athletic performance) or improved appearance (size, shape, definition). Improved appearance is the most frequently reported reason for use among gym-based weight trainers [31–36]. Among competitive athletes appearance enhancement is not the primary motive. In two studies involving elite power lifters, improved appearance was ranked only fourth, after reasons related to enhanced athletic performance, prevention or treatment of injuries and the perception that other competitors were using anabolic steroids [37,38].

In studies involving male high school students improved physical appearance was ranked second after athletic performance [39], or third after increased strength and increased size [40]. In other studies of both male and female high school students improved physical appearance has generally been the second or third most commonly reported reason for use after increased size, increased strength and improved athletic performance [22,41–44].

There is strong evidence that many anabolic steroid users, especially those involved in gym-based weight training, are using these drugs to enhance their appearance. Further research is needed to un-

derstand better the complexity of the body image issues associated with this pattern of anabolic steroid use.

Recently, it has been suggested that by the year 2000 there will be a demand for these drugs by men over 50 to assist them to age “successfully”. It is claimed that testosterone therapy for men can prevent physical ailments and depression, strengthen ageing bodies and restore a waning interest in sex [19]. This demand among men could develop in much the same way as hormone replacement therapy for menopausal women.

Rates of usage

Anabolic steroid use questions were first included in the fourth Australian National Household Survey conducted in 1993. Three percent of respondents (14+ years) reported steroid use [45], with the extent of use ranging from 2.1% in the Australian Capital Territory to 5.4% in Western Australia. A similar survey in the United States yielded much lower rates, with just 0.5% of respondents admitting use in the past year (0.9% males and 0.1% females, 12+ years) [12]. This discrepancy between the surveys is not surprising, given that the US study was limited to use in the *past year* whereas the Australian study recorded *any prior use* of these drugs. There were also differences in the way the data were collected; the Australian study used a self-report questionnaire whereas the US survey was interview-based.

It is of note that 90% of Australians who admitted anabolic steroid use claimed to have taken the drugs for medical purposes, although the definition of such use was not made clear [45].

Usage among competitive athletes in Australia

A national survey of elite athletes conducted between 1979 and 1982 found that 5.4% of respondents had used a performance-enhancing substance during the previous year, and 1.0% had used anabolic steroids within the last 5 years [46]. In this study 22.4% of power lifters had used anabolic steroids, as had 15.7% of weight lifters, whereas sports such as track and field (1.4%) and cycling (1.1%) reported much lower rates. In a 1989 survey of first grade rugby league players, 25.0% of respondents were aware of either stimulants or anabolic

steroids being used by players to enhance performance [33].

Inquiries conducted by both the Australian [2] and Canadian [3] governments into drugs in sport found evidence of drug use among elite athletes in a wide range of sports. In addition drug use was also identified across a wide variety of sports in Australia at sub-elite levels, in particular involving weight trainers [2]. For detailed history of anabolic steroid use in sport and exercise see Yesalis *et al.* [47].

Usage among weight trainers

Table 1 presents a summary of studies investigating anabolic steroid use among weight trainers. It is difficult to make sense of this diverse range of studies, due to the widely differing methodologies employed and the range of samples surveyed. Many of the studies have involved small or undefined samples and have not reported response rates or provided details related to their selection of sampling locations. Anecdotal reports indicate extremely high rates of usage: it has been claimed that between 70% and 80% of non competitive body builders attending Australian gyms may use anabolic steroids [48], and that the majority of national level power lifters in the United States have used these drugs [37,38].

Reports from gym studies vary widely, and may reflect differences in the clientele attending these gyms. In studies of so-called "hard-core" gyms, which attract power lifters and those seriously committed to body building, usage rates of 30–40% have been reported [31,49–52].

Studies involving gyms with a wider cross-section of weight trainers have reported lower rates of anabolic steroid use. One of the most comprehensive studies by Korkia & Stimson (1993), investigating anabolic steroid use among weight trainers in 21 gyms throughout the United Kingdom, found that 7.7% of gym participants had used them at some time, and 5.0% were currently using. Usage rates varied across the 21 gyms surveyed from 0% to 46% of respondents [35]. An Australian survey of 197 weight trainers recruited from gymnasiums and a body building association found that 16.2% had used anabolic steroids (18.2% of the males and 9.3% of the females) [36]. The only published US gym study that has outlined the method of gym selection involved five gyms in metropolitan California with

membership over 300 and a minimum of 50% of their members participating in strength training [34]. In this study 14.6% (14.0 males and 0.6% females) had used anabolic steroids.

A recent survey of exercise and recreational habits conducted in Queensland found that gym based activity (body building and weight training) was the fifth most common physical activity, involving 10.8% of the population aged 15 years and over who are active [53]. The majority (98%) of gym activity is non-competitive and most participants (89%) engage in it more than once per week. Among active 15–24-year-olds body building and weight training (15.9%) ranked second behind walking (17.5%) as the most common activity engaged in on a regular basis during the previous year. Given this pattern of gymnasium-based weight training, and assuming 5–10% of gym attending weight trainers have used anabolic steroids it is estimated that between 25 000 and 50 000 young people (18–34) training at gyms in Australia have used anabolic steroids.

Usage among high school students

There seems to be consistency across Australian high school surveys with anabolic steroids usage rates ranging from 1.2% to 3.2% for males and 0.2% to 2.0% for females [5,45,54–57]. These rates appear to be similar to those in Canada, where a national study found that 2.8% of students aged between 11 and 18 years had used anabolic steroids (4.1% of males and 1.5% of females) [42]. In the United States the level of use is greater, with a large national study finding that 6.6% of males in the 12th grade had used [39]. There is evidence of regional differences across the United States where rates have varied from 2.7% to 4.4% (4.0–7.6% for males and 1.3–2.5% for females) in studies reported since 1990 from Alabama, Arkansas, Chicago, Denver, Georgia and Utah [43,44,61–64]. A study of 9th and 10th grade students in three high schools in a county of New York State found that 10.9% had injected anabolic steroids in the past year (15.3% of the males and 6.7% of the females) [60]. Usage appears to increase with age among male high school students. In the national Canadian study the use by males increased from 3% among 13 and 14-year-olds to 5% among 15–17-year-olds to 7% among 18+ year olds, while for adolescent females the rate varied between 1% and 2% [42].

Table 1. *Self-reported steroid use among weight trainers*

Investigator and year	Site and population	Subjects (number)	Percent steroid use		Percent response
			Ever	Currently	
Strauss <i>et al.</i> , 1983	US several gyms body builders & power lifters	32	90.6	62.5	NR
Frankle <i>et al.</i> , 1984	US 3 gyms weight trainers	250	44.0		NR
McKillop, 1987	Scotland 1 gym body builders	41	19.5		NR
Taylor & Black, 1987	US 1 gym weight trainers	114	90.4		NR
Yesalis <i>et al.</i> , 1988	US, survey elite power lifters	45 20	33.3 mail 55.0 phone		73.8 100.0
Tricker <i>et al.</i> , 1989	US mail survey body builders	176		37.5 (M = 54.6, F = 10.3)	46.3
Bahrke <i>et al.</i> , 1992	US 1 gym weight trainers	50	52.0	24.0	NR
Perry <i>et al.</i> , 1992	Wales gyms weight trainers	160	38.8		53.3
Kersey, 1993	US 5 gyms weight trainers	185	14.6 (M = 14.0, F = 0.6)		NR
Korkia & Stimson, 1993	UK, 21 gyms weight trainers	1659	7.7 (M = 9.1, F = 2.3)	5.0 (M = 6.0, F = 1.4)	NR
Chee <i>et al.</i> , 1994	Australia, 7 gyms weight trainers	197	16.2 (M = 18.2, F = 9.3)		35.6
Gridley & Hanrahan, 1994	Australia, 6 gyms body builders & power lifters	60	35.0 (M = 37.5, F = none)		34.1
Wagman <i>et al.</i> , 1995	US, survey elite power lifters	15	66.7	46.7	57.7

NR = not reported.

Age of users

The majority of current users in the United States are under 26 years old, with the median age of first use being 18 years (mode, 17 years) [12]. An Australian study found that the average age of current

injecting users was 26 years (range 17–38), with the average age of first use being 22 (range 12–36) [58]. The average age of weight training users is generally between 24–30 years [31,32,35,37,49,51,52,59,60,61] with the average age of first use 18–24 years [32,35,37,59,61].

Research difficulties

Most of the research on the physiological or behavioural effects associated with use has involved animal studies. Reported studies of humans have either been case studies or inadequately controlled studies of athletes. It is difficult to extrapolate these findings to the "real world" where anabolic steroid use can involve doses among heavy users of 5–10 times, but in some cases up to 30 times, greater than would be prescribed medically [41,51,58,59,61,62–65].

Moreover, the patterns of use involving "stacking" (taking two or more anabolic steroids at once), and "cycling on" (e.g. taking steroids for 6–12 weeks, followed by a break), possibly involving a pyramid dosage schedule (low to high dosages, then tapering prior to stopping), make it difficult to extrapolate from the existing pharmacological and toxicological data to the situation among users. The use of veterinary steroids and counterfeit steroids further complicates any attempt to monitor side-effects because detailed toxicity data have not been published for most of these agents [18].

A further level of complexity involves individual differences in response, together with the age and health of the user. Often users are taking multiple drugs of unknown composition and without supervision, making it difficult to identify, let alone isolate, side-effects experienced.

There is also the unavoidable problem of investigating what is essentially an illicit activity. It has been suggested that reluctance to acknowledge use may mean that the available data represent a significant underestimate of actual usage [66].

Physical side effects

Side effects experienced depend on the specific drug taken, the size and frequency of doses, duration of use, route of administration and the age and health of the user. There are also individual differences in response to steroids.

Adverse effects associated with anabolic steroid use have been widely studied and reviewed [18,21,22,25,67–69]. For a detailed review of the effects of anabolic steroids on physical health see Friedl (1993) [70]. In many instances the information available has been derived from case studies and short-term users. The need for studies specifically investigating the long-term effects of anabolic steroid use has been identified [1,69].

Anabolic steroid use by strength-trained athletes may increase the risk of coronary heart disease, in particular involving atherosclerosis, due to changes in the serum lipoprotein profiles of users, combined with fluid retention, hypertension and clotting abnormalities [73,74]. A review by Graham & Kennedy concluded that steroids uniformly induce an adverse serum lipoprotein profile, with these effects being more pronounced with C-17 derivatives (oral steroids) than with the testosterone esters (injectable steroids) [68].

In Australia two cases have been reported where anabolic steroid use has been linked to fatal heart attacks [71] and one case where a user died of a cerebral haemorrhage [72], but given the small number of such cases and the possible presence of other predisposing factors, it is difficult to conclude that anabolic steroid use increases the risk of these conditions.

Cases of musculoskeletal damage involving rupturing of tendons have been associated with anabolic steroid use [75]. A review by Laseter & Russell proposed that tendon ruptures were possibly due to the development of connective tissue abnormalities which significantly decrease the tensile strength of tendons [76]. In addition it was suggested that the use of anabolic steroids results in greater motivation and heavier work/training loads which do not allow the body time to adapt adequately and that ligaments and tendons are not able to heal or build as quickly as muscle and therefore rupture due to the strain of increased muscle strength [77].

Potential complications associated with anabolic steroid use in both males and females include growth of facial hair, deepening of the voice, skin rashes, acne, oedema (water retention), jaundice and increases in libido, appetite and aggressiveness. Problems specific to males include gynaecomastia (enlargement of the breasts), transient infertility and testicular atrophy, while females users have reported decreased breast size and menstrual irregularities. Serious chronic side effects are generally associated with liver disease, cardiovascular disease and sterility [67,69,77].

Although the potential for serious long-term problems exists there is some evidence that the vast majority of users do not experience such problems [80]. There is evidence from controlled studies that anabolic steroid use can yield positive physical side effects such as increased serum immunoglobulins,

which improves general immunity [78], and an enhancement of sexual desire [79].

A longitudinal Australian study of 169 "casual athletes" who were medically prescribed anabolic steroids found that side-effects were minimal and reversible. During the 5-year trial (1987–1991) anabolic steroid use did not produce any significant problems in the short term (up to 5 years) [81]. However, it is not clear what the pattern of harm may be in the longer term, especially in those who have been chronic users, or who have ingested doses well in excess of levels prescribed medically.

Psychological side effects

Mood disorders

A number of studies have investigated the incidence of mood disturbance in anabolic steroid users. Pope & Katz [82] found a highly significant relationship between the level of steroid use and mood disorder among 88 steroid using athletes. Affective disorders including mania, hypomania and major depression were evident in 23% of these subjects, and were most likely to occur when the athlete was taking the drug. Mood disorders were more common in the users than in non-using controls.

Serious mood disorders were also evident in a group of 41 body builders and footballers who had used anabolic steroids [83]; nine subjects (22%) met DSM-III-R criteria for a manic or depressive episode while taking the drugs or during withdrawal. These subjects reported remission of symptoms within a few weeks of stopping.

However, two other studies found no differences between anabolic steroid users and controls on major mental disorders [61] or mood disturbance as measured by the Profile of Mood States Inventory [51], although in this latter study the users complained more often of experiencing depression, anxiety and hostility than the controls.

Aggression

Anabolic steroid use is often associated with self-reported increases in aggressiveness; this is a consistent finding across studies looking at male athletes [51,61,64,71,80,82,84], female athletes [85] and both sexes [12,32,35,52,59]. Mood swings [21,52,62] and irritability [35,37,51,60,61,71,80,82,84] are also commonly associated with steroid use. It

should be noted that many of the earlier studies have methodological problems such as: not controlling for poly drug use, poor definition of what constitutes aggressive behaviour, not validating the drugs reported being used, no control groups, inappropriate sampling, self-reporting and not distinguishing between classes of anabolic steroids [1,62,86–88].

There is a growing body of case studies linking steroid use and aggressive behaviour, often involving violent crimes [89–92]. For example, Pope & Katz suggested that anabolic steroids played an important, if not primary, role in two cases of homicide and one of attempted homicide, in men with no evidence of predisposing factors [84], and Choi & Pope (1994) found that male strength athletes reported significantly more fights, verbal aggression and violence towards their partners while on anabolic steroids (but not when off steroids) than a control group [93].

However, these studies do not demonstrate a causal link between anabolic steroid use and aggression. Many factors may contribute to aggressive behaviour. For example, a variable recognized as a possible confounding factor is the socialisation/learning process associated with the anabolic steroid weight training sub-culture, where the overt expression of aggression is common [1,94,95]. It is represented both in the language and behaviour of the participants; terminology such as "blitzing", "bombing" and "attacking" the weights reflect the aggressive attitude of the lifter towards their weights. Physical and verbal expressions of aggression are common [96]. Researchers speculate that the socialization process within this sub-culture could lower weight trainers' aggression threshold and lead to more overt displays of aggression [88–96]. Social sanctions that restrict the overt display of aggression appear to be relaxed and there is positive reinforcement for aggressive acts, even if the aggression is self-directed [96]. Indeed, aggression is seen as a desirable emotion as it improves the training intensity [85–96].

Bahrke *et al.* [88] offer an alternative hypothesis based on an interaction between anabolic steroid induced effects and personal coping inadequacies. They argue that in the absence of adequate external constraints, internal discipline or social coping skills, the cumulative effects of increased arousal, enhanced self-confidence and elevated pain threshold that can result from anabolic steroid use may lead to the expression of aggression at inappropriate times.

Comprehensive literature reviews suggest that there is a relationship between anabolic steroid use and aggression, but the nature of this relationship remains unclear and the available data does not establish a clear causal link [88,97,98].

Dependency issues

Symptoms frequently associated with drug dependence have been reported by individuals using anabolic steroids, and include preoccupation with drug use, drug craving, increased tolerance and withdrawal symptoms that respond to anabolic steroid replacement [99,100]. The accelerating use of the drug, which is characteristic of dependency, is evident in many anabolic steroid users with their dose levels and number and length of cycles increasing over time [41,50,52,59,64,101]. In a study of 49 male weight lifters using steroids, over half (57%) were diagnosed as dependent according to DSM-III-R criteria [47], while case studies of anabolic steroid dependent individuals have been reported [102].

Withdrawal symptoms are commonly reported; following cessation of anabolic steroids, users report feeling depressed [35,59,61,62,103,104], fatigued [35,59] and experience anorexia, insomnia and decreased libido [59,103]. Physical withdrawal symptoms reported include hot and cold flushes, sweats, anorexia, myalgias, nausea, piloerection (goose-bumps) and increase in pulse rate and blood pressure [99].

Dependent individuals who use anabolic steroids to improve their physical appearance and become obsessed with their new body image have been likened to individuals suffering from an eating disorder [7,103,105]. Haupt [7] referred to the obsession with body image seen in steroid users as a form of "reverse anorexia", while Corcoran & Longo argue that the psychological changes that accompany the hormonal and physiological changes observed in anabolic steroid users are similar to those seen in anorexia [105]. Once a person has begun anabolic steroid use it has been reported that the positive effects associated with the drug become reinforcers and reasons to continue use [24,58,59]. Malone *et al.* [106] postulated that the lifestyle and rewards associated with anabolic steroid use contribute to dependency, but noted that it was rare for non-competing subjects to experience problems of dependency.

Given that so many anabolic steroid users show symptoms of dependence, it is important to consider these drugs as potentially addictive, and research attention should be directed at better understanding the mechanisms underlying this dependency.

Sources of steroids

It is widely accepted that anabolic steroids are easy to obtain in Australia [2,5,9] and overseas [35]. For most users the black market (defined as any source other than medically prescribed) is the main source of these drugs [34,35,38,43,60,107,108–111]. Typically, users obtain the drug from a friend [5,9,34,35,38,107,108], although sources are many and varied and include pharmacists, coach/trainers, relatives, gym personnel, veterinarians, dealers and mail order. In 1989 the black market in anabolic steroids in Australia was estimated to be worth between \$15 million and \$150 million [2].

While the black market remains the major source of anabolic steroids, many users obtain their drugs legally from doctors. Between 4% and 33% of US high school students who have used steroids obtained the drugs on medical prescription [39,41,43,44,107,109]. Among gym based weight trainers, between 2% and 20% of users claimed to have been given medical prescriptions for the drugs [32,34,35,50]. A study of technical college students in the United Kingdom found that 17.0% of users obtained their anabolic steroids from a medical professional (either a physician or pharmacist) [111]. There is evidence from the United States that more sophisticated users, e.g. body builders and power lifters, are more likely than other weight trainers to be obtaining anabolic steroids from a medical professional, with between 18.0% and 41.0% doing so [37,110,112].

Australian figures suggest that a significant proportion of anabolic steroids use is medically prescribed, with rates varying from 5% to 50% [2,5,9,58]. In a study of injecting drug users over half (51.5%) had obtained them on prescription, although this may over-represent the prescription rate, as a significant proportion of users were recruited as a result of their attendance at a medical clinic prescribing anabolic steroids; when these subjects were excluded, the medically prescribed user rate dropped to 36.3% [58]. It would appear that anabolic steroids are readily available on the black

market, but a significant percentage of users obtain them on medical prescription.

Needle sharing issues

An increasing number of anabolic steroid users are injecting these drugs; needle exchange operations report that steroid users represent an increasing proportion (between 25% and 40% in 1992) of their case-load [113].

It is difficult to determine how much needle-sharing occurs among anabolic steroid users. In an Australian study of injecting users, 8.4% knew of other users who were currently sharing injecting equipment but only one respondent admitted sharing. [58]. There is virtually no self-reported sharing of needles. This has been attributed to the anabolic steroids user's concern for health, the availability of injecting equipment and the needle education programmes associated with the National AIDS campaign.

Korkia & Stimson (1993) found that 71.8% of users were injecting (80.9% had injected in the past), with 5.6% of current injectors admitting that they had shared a needle or syringe [35]. A Welsh study found 75.8% of users had injected, of whom 4.2% had shared needles in the past, although 12.8% of injecting users reported that they had lent their equipment to other users [49]. Studies in the United States report high rates of injecting (between 80% and 100%) [51,59,110].

Studies of US and Canadian high school students report that between 25.6% and 38.1% of users have injected [39,42,114,115]. Rates of needle-sharing varied from 9.1% [115] to 29.1% [42]. For example, in a study of high school students in Arkansas, ($n = 1881$) 78 (4.2%) admitted having used anabolic steroids, of whom 20 (25.6%) admitted injecting and almost all (18/20) of these injecting users admitted sharing needles [114].

Two cases have been reported of body builders who tested HIV positive after sharing needles to inject anabolic steroids [116,117]. Despite the low reported incidence, the practice of needle sharing among anabolic steroid users indicates that the potential exists for the transmission of HIV and other blood-borne viral infections. Of particular concern is a study suggesting that high school steroid users have a lower knowledge level about AIDS/HIV and its prevention than non-users [118].

In reviewing these studies it is not possible to determine if the reported differences in needle-sharing behaviour are due to changes over time, cultural factors, social factors or access to equipment. It is also possible that needle sharing behaviour is under reported among injecting anabolic steroid users due to the stigma attached to admitting such potentially risky behaviour [37].

Legal issues and structural interventions

It is widely accepted that there exists a precedent and mandate for the community to be protected from behaviour that may cause harm to either the individual or others. This is demonstrated by legislation that restricts, for example, illicit drugs of dependence and firearms and specifies work-place safety practices [119]. There is evidence from legislation on anabolic steroids that purchasing patterns can be modified by restricting supply and increasing criminal sanctions [120,121]. Legislators need to consider the unintended consequences of changing legislation. For example, the primary consequence may be to restrict availability, but the secondary consequence may be to influence purchasing patterns in ways that move users to other forms of anabolic steroids.

Anabolic steroid users differ from other illicit drug users. Typically users often have a health and physical fitness orientation and an obsession with physique [58,122]. They often report seeking information on the consequences of anabolic steroid use and appear to be motivated by health concerns rather than legal sanctions [58].

The drug is consumed in different social contexts from other illicit drugs, there is limited psychotropic [35] effect and there appears to be little harm to the community. As ways of minimizing anabolic steroid use, increased penalties would appear to be ineffective as a deterrence strategy among non-competitive users. For example, Western Australia currently has both the highest reported rate of anabolic steroid use [45] and the most severe penalties. Increasing legal sanctions could result in an increase in harm and provide opportunity for illegal distributors to profit from the drug. The further marginalizing of anabolic steroid users from society may contribute to them being even less likely to seek appropriate advice and supervision [123,124].

To reinforce the public perception that anabolic steroid use is an unacceptable behaviour, structural

policies could include deterrence strategies such as increasing the profile and likelihood of competitive athletes being drug tested. This would ensure that role models reflect appropriate behaviour. Government funding could be increased for those sports and activities that incorporate drug testing (where appropriate). Investigation into the accreditation of sports such as body building and associated testing should be examined. The second author has interviewed several sports people in high profile contact sports who have reported cessation of anabolic steroid use due to the likelihood of being detected [125]. The potential loss of income and prestige motivated their cessation.

Drug education and prevention programmes

Although there is evidence in Australia of some anabolic steroid users being well informed, there is also evidence that there is a great deal of misinformation circulating about these drugs, highlighting the need for education programmes [4]. Yesalis & Bahrke argue for increasing demand reduction strategies by expanding education programmes; however there is little empirical evidence directly relating to the design of anabolic steroid prevention programmes [1,94].

Studies evaluating school-based drug-use prevention programmes in the United States have found little evidence of their effectiveness [126,127]. A meta-analysis of 143 adolescent drug prevention programmes found Peer Programmes to be superior and significantly different from all other programmes combined (knowledge only, affective only, knowledge plus affective and alternative programmes) [128]. An Australian study found that elite adolescent athletes favoured peer drug prevention programmes over those involving coaches and parents [129]. Nicholson *et al.* suggested that in Australia the ethical aspect, i.e. fair play in sport with anabolic steroid use involving cheating, should be promoted to help establish and reinforce a negative attitude towards performance-enhancing substances [130].

Although knowledge about the steroid subculture is limited there is evidence that information is shared along friendship and through hierarchical networks including gym instructors, successful body builders and private trainers [58,96,122,125]. This provides potential avenues to deliver prevention and harm minimization education programmes.

Studies have consistently found that anabolic steroid users have more positive attitudes towards use than non-users [44,107,108]. Studies of US college students have found that anabolic steroid users were significantly more knowledgeable about these drugs than non-users [44,108], but a study of US high school students found the reverse [107]. An Australian gym study found users were more knowledgeable about the positive effects than non-users, but were no more knowledgeable about the negative effects [31]. It has also been found, however, that knowledge of the risks associated with anabolic steroid use is not an effective deterrent among adolescents [44,108] and injecting steroid users [58].

A US study of college football players found that after an educational intervention awareness of adverse effects increases, but general attitudes towards anabolic steroid use did not differ between those completing the education programmes and controls [132]. In a related study comparing different educational programmes, a balanced programme outlining potential risks and benefits of anabolic steroids use was significantly more effective than a programme focused solely on the risks of use [132].

An anabolic steroid educational intervention that has shown promising results utilized many of the above recommendations [133,134]. The 'Adolescent Training and Learning to Avoid Steroids Program' (ATLAS) uses classroom and weight training educational sessions to correct misinformation, provide alternatives and to strengthen anti-anabolic steroid feelings. Peer, parental, team and teacher support were used as ways of supporting the participants. The ATLAS programme significantly reduced anabolic steroid risk factors such as positive perception of anabolic steroids and over-estimation of use by others [133,134]. It did not, however, significantly reduce anabolic steroid initiation among the intervention group compared to the control group. Researchers suggest that this may occur over several years. Annual follow up programmes that aim to decrease the decay effect are planned [133-134].

In Australia, educational material might be delivered through a range of channels including the Health Education Syllabus, gym instructors trained through accredited government programmes and TAFE and peer education. As these delivery modes use existing networks of users, and existing government programmes, they could present cost-effective ways of reaching the target group. Further research

is needed to determine the most effective content, style and focus of prevention programmes relevant to Australian anabolic steroid users.

Future directions

Given the diversity of reasons for use and types of users further information is needed before specifically targeted prevention programmes can be developed. A WHO review of drugs in sport emphasized the importance of understanding the social-psychological context of use before planning intervention programmes. Information is also required on patterns of use, sources of supply, needle-sharing behaviour, use of other drugs, knowledge levels and physical side-effects. In the vast majority of studies this information has been obtained via self-completion questionnaires administered either in a school setting or distributed to a given sample to be completed and returned. Future studies should consider using face-to-face interviews, preferably involving peer interviewers, in order to, first, minimize the often referred-to problem of under-reporting and, secondly, improve the quality and accuracy of the data. Attention also needs to be given to improving the representativeness of the population studied. Further research, including the use of focus groups and qualitative techniques, is needed to explore the social and cultural issues associated with steroid use, in particular factors associated with body image orientation. Scientifically designed and controlled studies are also needed to investigate the psychological effects of anabolic steroid use both in terms of mild mental state changes and severe psychiatric symptoms requiring treatment.

While the number of competitive athletes failing drug tests in Australia is low and declining from 2.7% in 1990–91 to 1.1% in 1994–95 [135,136], there is evidence that the use of performance-enhancing substances, in particular anabolic steroids, is an emerging problem among the wider population [4,9]. It is generally agreed that use is under-reported [12,35,39,55,59,109,110,137] because of respondents bias associated with, firstly, wanting to protect themselves and/or their sport's image and secondly, methodological problems associated with low response rates (e.g. the distribution of self-completion questionnaires without following-up refusals) and poor sampling techniques. It is reasonable, therefore, to assume that anabolic steroid

use is greater than currently indicated in the published scientific literature. Further studies are required to determine the prevalence of anabolic steroid use and to develop profiles of different populations of users.

One particular concern is the finding that around one-third of males and nearly 10% of females surveyed at four NSW private schools were considering future use [56]. Other studies have found significant numbers of potential users [5,31,43,54,131,132]. Further research to investigate the processes associated with initiation and continuing steroid use is needed.

Legal status should reflect the harm associated with the drug. To this end a standardized classification should be considered for use throughout Australia. Currently classifications and sanctions vary from state to state. In Australia veterinary steroids are being used by around 10% of users in both Western Australia and New South Wales [5,58]. The Australian inquiry into drugs in sport revealed that anabolic steroids produced for veterinary use are more attractive to users because they are cheaper than either medically prescribed or black market anabolic steroids and the legal penalties in each state tend to be less severe [2]. This is of particular concern, given that veterinary steroids have not been manufactured and tested for human consumption.

Despite increased legal sanctions, such as laws against possession, and the addition of non-prescribed anabolic steroids to the list of prohibited substances, the use of these drugs in Australia appears to be increasing among non-competitive athletes. Supply restriction (prohibition) and deterrence strategies (drug testing) have been described as ineffective in decreasing the use of anabolic steroids among amateur athletes outside the realm of the national drug testing programme for competitive athletes [138,139]. It is suggested that increasing the penalties associated with anabolic steroid use may only serve to force them underground, resulting in greater health risk and harm. Use tends to be associated with sub-cultures where it is embedded in a social context where demand reduction may be more effective in preventing or minimizing the harm associated with the use [96]. There is evidence that an understanding of the psychological needs associated with anabolic steroid use and the use of peer educators are necessary components of programmes aimed at harm minimization and prevention.

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References

- [1] Yesalis CE, Bahrke MS. Anabolic-androgenic steroids: current issues. *Sport Med* 1995;19:326–340.
- [2] Black J. Drugs in sport: an interim report of the Senate standing committee on environment, recreation and the arts. Canberra: Australian Government Publishing Service, 1989.
- [3] Dubin CL. Commission of inquiry into the use of drugs and banned practices intended to increase athletic performance. Ottawa: Canadian Government Publishing Centre, 1990.
- [4] Dillon P. A preliminary study of anabolic steroid using sub-cultures in inner city Sydney. Kensington New South Wales: National Drug and Alcohol Research Centre, University of New South Wales, 1995.
- [5] Mugford S. Development of anabolic steroids (and other anabolic substances) use indicators in Australia: final report. Canberra: Department of Human Services and Health, 1995.
- [6] Littlepage BNC, Perry HM. Misusing anabolic drugs: possibilities for future policies. *Addiction* 1993;88:1469–1471.
- [7] Haupt HA. Anabolic steroids and growth hormone. *Am J Sports Med* 1993;21:468–474.
- [8] Dart RC, Ferranto DA. Anabolic steroid abuse among law enforcement officers. *Police Chief* 1991;58:18.
- [9] Beel A. Anabolic steroid use amongst young people in Western Australia (preliminary research findings). Bentley Western Australia: National Centre for Research into the Prevention of Drug Abuse, Curtin University of Technology, 1995.
- [10] Wignell JF. Steroid users the unrecognized HIV risks the word for today “steroid”. *Proceedings Winter School in the Sun, Brisbane*;1994:273–277.
- [11] Harris W. Steroids and the quest for perfection. *Sydney Star Observer* 1993;16 April.
- [12] Yesalis CE, Kennedy NJ, Kopstein AN, Bahrke MS. Anabolic-androgenic steroid use in the United States. *JAMA* 1993;270:1217–1221.
- [13] Melia P. Sport for all: but is it suitable for children? *Int J Drug Pol* 1994;5:34–39.
- [14] Drugs of Dependence Branch. National drug strategy household survey report 1995. Canberra: Australian Government Publishing Service, 1996.
- [15] Yesalis CE, Buckley WE, Anderson WA, Wang MQ, Norwig JA, Ott G, Puffer JC, Strauss RH. Athletes' projections of anabolic steroid use. *Clin Sports Med* 1990;2:155–171.
- [16] Beckett A. The future of the Olympic movement. In: Laura RS, White SW (eds) *Drug controversy in sport: the socio-ethical and medical issues*. Sydney: Allen & Unwin, 1991.
- [17] Klarica AJ. Fast track to glory. *Aust Runner* 1995;15:10–15.
- [18] Wilson JD. Androgen abuse by athletes. *Endoc Rev* 1988;9:181–99.
- [19] Hoberman JM, Yesalis CE. The history of synthetic testosterone. *Sci Amer* 1995; Feb:60–5.
- [20] Celotti F, Negri Cesi P. Anabolic steroids: a review of their effects on the muscles, of their possible mechanism of action and of their use in athletics. *J Steroid Biochem Mol Biol* 1992;43:469–77.
- [21] Haupt HA, Rovere GD. Anabolic steroids: a review of the literature. *Am J Sports Med* 1984;12:469–84.
- [22] Lamb DR. Anabolic steroids in athletics: how well do they work and how dangerous are they? *Am J Sports Med* 1984;12:31–8.
- [23] Yesalis CE, Wright JE, Lombardo JA. Anabolic-androgenic steroids: a synthesis of existing data and recommendations for future research. *Clin Sports Med* 1989;1:109–34.
- [24] Elashoff JD, Jacknow AD, Shain SG, Braunsterin GD. Effects of anabolic-androgenic steroids on muscular strength. *Ann Intern Med* 1991;115:387–93.
- [25] Kennedy MC. Anabolic steroid abuse and toxicology. *Aust NZ J Med* 1992;22:374–81.
- [26] Friedl KE, Dettori JR, Hannan CJ, Patience TH, Plymate SR. Comparison of the effects of high dose testosterone and 19-nortestosterone to a replacement dose of testosterone on strength and body composition in normal men. *J Steroid Biochem Mol Biol* 1991;40:607–12.
- [27] Bhasin S, Storer T, Berman N, Callegari C, Clevenger B, Phillips J, Bunnell T, Tricker R, Shirazi A, Casaburi R. The effects of supraphysiologic doses of testosterone on muscle size and strength in normal men. *N Engl J Med* 1996;335:1–7.
- [28] National Drug Strategy Committee. *National Drug Strategic Plan 1993–1997*. Canberra: Australian Government Publishing Service, 1993.
- [29] Bednarek J. Pumping iron or pulling strings: different ways of working out and getting involved in body-building. *Int Rev Soc Sport* 1985;20:239–59.
- [30] Beel A, Scott M. Finding of the anabolic steroids workshop: “Future directions for research and policy”. Bentley Western Australia: National Centre for

- Research into the Prevention of Drug Abuse, Curtin University of Technology, April 1995.
- [31] Gridley DW, Hanrahan SJ. Anabolic-androgenic steroid use among male gymnasium participants: dependence, knowledge and motives. *Sport Health* 1994;12:11-14.
- [32] Taylor WN, Black AB. Pervasive anabolic steroid use among health club athletes. *Ann Sports Med* 1987;3:155-9.
- [33] Sivyer G. Sport and the use of stimulants. Paper presented at the Winter School in the Sun, Brisbane, 1992:191-203.
- [34] Kersey RD. Anabolic-androgenic steroid use by private health club/gym athletes. *J Strength Cond Res* 1993;7:118-26.
- [35] Korkia P, Stimson GV. Anabolic steroid use in Great Britain. London: Centre for Research on Drugs and Health Behaviour, 1993.
- [36] Chee R, Kuan M, Rynn C, Teoh B. Anabolic steroid usage in gyms (unpublished fifth year medical student project No. 9404), Nedlands: University of Western Australia, 1994.
- [37] Yesalis CE, Herrick RT, Buckley WE, Friedl KE, Brannon D, Wright J. Self-reported use of anabolic-androgenic steroids by elite power lifters. *Phys Sports Med* 1988;16:91-100.
- [38] Wagman DF, Curry LA, Cook DL. An investigation into anabolic androgenic steroid use by elite U.S. powerlifters. *J Strength Cond Res* 1995;9:149-54.
- [39] Buckley WE, Yesalis CE, Friedl KE, Anderson WA, Streit AL, Wright JE. Estimated prevalence of anabolic steroid use among male high school seniors. *JAMA* 1988;260:3441-5.
- [40] Johnson MD, Jay MS, Shoup B, Rickert VI. Anabolic steroid use by male adolescents. *Pediatrics* 1989;83:921-4.
- [41] Kusserow RP. Adolescents and steroids: a user perspective. USA: Department of Health and Human Services, 1990.
- [42] Canadian Centre for Drug-Free Sport. National School Survey on Drugs and Sport: final report. Ontario: Canadian Centre for Drug-Free Sport, Gloucester, Ontario, 1993.
- [43] Terney R, McLain LG. The use of anabolic steroids in high school students. *Am J Dis Ch* 1990;144:99-103.
- [44] Komoroski EM, Rickert VI. Adolescent body image and attitudes to anabolic steroid use. *Am J Dis Child* 1992;146:823-8.
- [45] Department of Health, Housing and Community Services. National household survey report. Canberra: National Campaign Against Drugs, Canberra, 1993.
- [46] Haynes S. Survey of drug use in Australian sport. Canberra: Australian Sports Medicine Federation, 1982.
- [47] Yesalis C, Courson S, Wright J. History of anabolic steroid use in sport and exercise. In: Yesalis C. (ed.) *Anabolic steroids in sport and exercise*. Champaign: Human Kinetics Publishers, 1993:35-47.
- [48] Causton S. Pump it up: steroid use by young people. *Connexions* 199 3;13:2-7.
- [49] Perry HM, Wright D, Littlepage BNC. Dying to be big: a review of anabolic steroid use. *Br J Sports Med* 1992;26:259-61.
- [50] Frankle MA, Cicero GJ, Payne J. Use of androgenic anabolic steroids by athletes. *JAMA* 1984;252:482.
- [51] Bahrke MS, Wright JE, Strauss RH, Catlin DH. Psychological moods and subjectively perceived behavioural and somatic changes accompanying anabolic-androgenic steroid use. *Am J Sports Med* 1992;20:717-24.
- [52] Tricker R, O'Neill MR, Cook D. The incidence of anabolic steroid use among competitive body-builders. *J Drug Educ* 1989;19:313-25.
- [53] ABS Cat. No. (4110.3) Participation in sporting and physical recreational activities. Queensland, October 1993.
- [54] Victorian Drug Strategy Section. School students and drug use. Melbourne: Department of Health and Community Services, 1993.
- [55] Henderson R, Kelley B, Sheehan M. Drugs in sport: the use of performance enhancing substances by high school students. Paper presented at Winter School in the Sun Conference, Brisbane, 3-6 July 1990.
- [56] McGufficke A, Rowling L, Bailey M. Drug use by adolescent athletes. *Youth Studies* 1990;9:47-50.
- [57] Odgers P, Houghton S, Douglas G. Prevalance and frequencies of drug use among Western Australian metropolitan high school students (unpublished, cited in Western Australian Task Force on Drug Abuse Report "Protecting the Community", volume 2 pp. 167-8).
- [58] Plowright S. Harm minimisation and anabolic steroids, Assisting Drug Dependents Inc. ACT 1993.
- [59] Brower KJ, Blow FC, Young JP, Hill EM. Symptoms and correlates of anabolic-androgenic steroid dependence. *Br J Addict* 1991;86:759-68.
- [60] Strauss RH, Wright JE, Finerman GAM, Catlin DH. Side effects of anabolic steroids in weight-trained men. *Phys Sports Med* 1983;11:86-96.
- [61] Perry PJ, Yates WR, Andersen KH. Psychiatric symptoms associated with anabolic steroids: a controlled, retrospective study. *Ann Clin Psychiatry* 1990;2:11-17.

- [62] Pope HG Jr, Katz DL. Affective and psychotic symptoms associated with anabolic steroid use. *Am J Psychiatry* 1988;145:487-90.
- [63] Kashkin K. Anabolic steroids. In: Lowinson JH, Ruiz P, Millman RB, Langrod JG (eds) *Substance abuse: a comprehensive textbook*, 2nd edn. Baltimore: Williams and Wilkins, 1992.
- [64] Bever DL, Lowry DR. Anabolic steroid usage in weight-trained athletes. *Health Educ Res* 1987;2:157-60.
- [65] McKillop G. Drug abuse in body builders in the West of Scotland. *Scot Med J* 1987;32:39-41.
- [66] Freenchick GS. Validity of self reporting in identifying anabolic steroid use among weight lifters. *J Gen Int Med* 1996;11:554-6.
- [67] Friedl KE. Reappraisal of the health risks associated with the use of high doses of oral and injectable androgenic steroids. In: Lin G, Erinoff L. (eds) *Anabolic steroid abuse*, National Institute of Drug Abuse Research Monograph Series 102. Rockville, MD: US Department of Health and Human Services, 1990:142-77.
- [68] Graham S, Kennedy M. Recent developments in the toxicology of anabolic steroids. *Drug Safety* 1990;5:458-76.
- [69] Hickson RC, Ball KL, Falduto MT. Adverse effects of anabolic steroids. *Med Toxicol Adverse Drug Exp* 1989;4:254-71.
- [70] Friedl KE. Effects of anabolic steroids on physical health. In: Yesalis CE. (ed.) *Anabolic steroids in sport and exercise*. Illinois: Human Kinetics Publishers, 1993:107-50.
- [71] Kennedy MC, Lawrence C. Anabolic steroid abuse and cardiac death. *Med J Aust* 1993;158:346-8.
- [72] Moss-Newport J. Anabolic steroid use and cerebellar haemorrhage. *Med J Aust* 1993;158:794.
- [73] Hurley BF, Seals DR, Hagberg JM, Goldberg AC, Ostrove SM, Holloszy JO, Wiest WG, Goldberg AP. High-density-lipoprotein cholesterol in bodybuilders versus powerlifters: negative effects of androgen use. *JAMA* 1984;252:507-13.
- [74] Taylor WN. Synthetic anabolic-androgenic steroids: a plea for controlled substance status. *Phys Sports Med* 1987;15:140-50.
- [75] Liow RYL, Tavares S. Bilateral rupture of the quadriceps tendon associated with anabolic steroids. *Br J Sports Med* 1995;29:77-9.
- [76] Laseter JT, Russell JA. Anabolic steroid-induced tendon pathology: a review of the literature. *Med Sci Sports Exerc* 1991;23:1-3.
- [77] Johnson MD. Anabolic steroid use in adolescent athletes. *Pediatr Clin N Am* 1990;37:1111-23.
- [78] Calabrese LH, Kleiner SM, Barna BP, Skibinski CI, Kirkendall DT, Lahita RG, Lombardo JA. The effects of anabolic steroids and strength training on the human immune response. *Med Sci Sports Exerc* 1989;21:386-92.
- [79] Moss HB, Panzak GL, Tarter RE. Sexual functioning of male anabolic steroid abusers. *Arch Sex Behav* 1993;22:1-12.
- [80] Silvester LJ. Self-perceptions of the acute and long-range effects of anabolic-androgenic steroids. *J Strength Cond Res* 1995;9:95-8.
- [81] Millar AP. Licit steroid use—hope for the future. *Br J Sports Med* 1994;28:79-83.
- [82] Pope HG, Katz DL. Psychiatric and medical effects of anabolic-androgenic steroid use. *Arch Gen Psychiatry* 1994;51:375-82.
- [83] American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*, third edition, revised. Washington, DC: American Psychiatric Association, 1987:165-85.
- [84] Pope HG, Katz DL. Homicide and near-homicide by anabolic steroid users. *J Clin Psychiatry* 1990;51:28-31.
- [85] Strauss RH, Ligggett MT, Lanese RR. Anabolic steroid use and perceived effects in ten weight trained women athletes. *JAMA* 1985;253:2871-3.
- [86] Ehrenkranz J, Bliss E, Sheard M. Plasma testosterone: correlation with aggressive behaviour and social dominance in man. *Psychosom Med* 1974;36:469-74.
- [87] Freinhair J, Alvarez W. Androgen-induced hypomania. *J Clin Psych* 1985;46:354-5.
- [88] Bahrke M, Yesalis C, Wright J. Psychological and behavioural effects of endogenous testosterone levels and anabolic-androgenic steroids among males. *Sports Med* 1990;10:303-37.
- [89] Dalby JT. Brief anabolic steroid use and sustained behavioral reaction. *Am J Psychiatry* 1992;149:271-2.
- [90] Schulte HM, Hall MJ, Boyer M. Domestic violence associated with anabolic steroid abuse. *Am J Psychiatry* 1993;150:348.
- [91] Campbell IA. Aggressive psychosis in Aids patient on high-dose steroids. *Lancet* 1987; September 26:750-1.
- [92] Conacher GN, Workman DG. Violent crime possibly associated with anabolic steroid use. *Am J Psychiatry* 1989;146:679.
- [93] Choi PYL, Pope HG. Violence towards women and illicit androgenic-anabolic steroid use. *Ann Clin Psychiatry* 1994;6:21-5.
- [94] Ardito F, Goldstein P, Bahrke M, Sattler T. Anabolic steroid use: prevention and education. *Int Natl J Drug Policy* 1994;5:27-33.
- [95] Rada R, Kellner R, Winslow W. Plasma testosterone and aggressive behaviour. *Psychosom Med* 1976;17:138-41.
- [96] Klein A. *Little big men: bodybuilding subculture and gender construction*. New York: State University of New York Press, 1993.

- [97] Olwea D, Mattesson A, Schalling D, *et al.* Testosterone aggression, physical and personality dimensions in normal adolescent males. *Psychosom Med* 1980;42:253-69.
- [98] Uzych L. Anabolic-androgenic steroids and psychiatric-related effects; a review. *Can J Psychiatry* 1992;37:23-7.
- [99] Kashkin KB, Kleber HD. Hooked on hormones? An anabolic steroid addiction hypothesis. *JAMA* 1989;262:3166-70.
- [100] Hays LR, Littleton S, Stillner V. Anabolic steroid dependence. *Am J Psychiatry* 1990;147:122.
- [101] Yesalis CE, Streit AL, Vicary JR, Friedl KE, Brannon D, Buckley W. Anabolic steroid use: indications of habituation among adolescents. *J Drug Educ* 1989;19:103-16.
- [102] Brower KJ, Blow FC, Beresford TP, Fuelling C. Anabolic-androgenic steroid dependence. *J Clin Psychiatry* 1989;50:31-3.
- [103] Brower KJ, Eliopoulos GA, Blow FC, Catlin DH, Beresford TP. Evidence for physical and psychological dependence on anabolic steroids in eight weight lifters. *Am J Psychiatry* 1990;147:510-12.
- [104] Perry HM, Hughes GW. A case of affective disorder associated with the misuse of 'anabolic steroids'. *Br J Sports Med* 1992;26:219-220.
- [105] Corcoran JP, Droz Longo E. Psychological treatment of anabolic-androgenic steroid-dependent individuals. *J Subst Abuse Treat* 1992;9:229-35.
- [106] Malone DA, Dimeff RJ, Lombardo JA, Sample RH. Psychiatric effects and psychoactive substance use in anabolic androgenic steroid users. *Clin J Sports Med* 1995;5:25-31.
- [107] Luetkemeier MJ, Bainbridge CN, Walker J, Brown DB, Eisenman PA. Anabolic-androgenic steroids: prevalence, knowledge, and attitudes in junior and senior high school students. *J Health Educ* 1995;26:4-9.
- [108] Chng CL, Moore A. A study of steroid use among athletes: knowledge, attitude and use. *Health Educ* 1990;21:12-17.
- [109] Windsor R, Dumitru D. Prevalence of anabolic steroid use by male and female adolescents. *Med Sci Sports Exerc* 1989;21:494-7.
- [110] Van Raalte JL, Cusimano KA, Brewer BW. Perceptions of anabolic steroid users. *J Appl Soc Psychol* 1993;23:1214-25.
- [111] Williamson DJ. Anabolic steroid use among students at a British college of technology. *Br J Sports Med* 1993;27:200-1.
- [112] Haislip GR. International conference on the abuse and trafficking of anabolic steroids, Prague, Czech Republic, 7-10 December 1993, p. 32.
- [113] Shapiro H. Adjusting to steroid users. *Druglink* 1992; Sept/Oct:16-17.
- [114] DuRant RH, Rickert VI, Ashworth CS, Newman C, Slavens G. Use of multiple drugs among adolescents who use anabolic steroids. *N Engl J Med* 1993;328:922-6.
- [115] Adlaf EM, Smart RG. Characteristics of steroid users in an adolescent school population. *J Alcohol Drug Educ* 1992;38:43-9.
- [116] Sklarek HM, Mantovani RP, Erens E, Heisler D, Niederman MS, Fein AM. Aids in a bodybuilder using anabolic steroids. *N Engl J Med* 1984;311:1701.
- [117] Scott MJ, Scott MJ Jr. HIV infection associated with injections of anabolic steroids. *JAMA* 1989;262:207-8.
- [118] Jones CS, Perko M, Nagy S, Wang MQ. AIDS knowledge in adolescent anabolic steroid users. *J Health Educ* 1994;25:19-23.
- [119] Roemer R. Public health and the law. In: Holland W, Detels R, Knox G (eds) *Oxford textbook of public health*, vol 1. Oxford: Oxford Medical Publications, 1995.
- [120] Bahrke MS. International conference on abuse and trafficking of anabolic steroids. *Int J Drug Policy* 1994;5:23-26.
- [121] Conference on the impact of national steroid control legislation in the USA. *J Perf Enhanc Dr* 1996;1:29-32.
- [122] Goldstein P. Anabolic steroids: an ethnographic approach. In: Lin G, Erinoff L (eds) *Anabolic steroid abuse*, National Institute of Drug Abuse Research Monograph Series 102. Rockville, MD: US Department of Health and Human Services, 1990:74-95.
- [123] Guttman N. Ethical dilemmas in health campaigns. Presented at the Annual Conference of the International Communication Association, 1995.
- [124] Yeo M. Towards an ethic of empowerment for health promotion. *Health Pro Int* 1993;8:225-35.
- [125] Maycock B. Socialisation processes, social structure and cultural dimensions of anabolic steroid use (preliminary research findings). Perth: Centre for Health Promotion Research, Curtin University of Technology, 1997.
- [126] Ennett ST, Rosenbaum DP, Flewelling RL, Bieler GS, Ringwalt CL, Bailey SL. Long-term evaluation of drug abuse resistance education. *Addict Behav* 1994;19:113-25.
- [127] Coggans N, Shewan D, Henderson M, Davies JB. The impact of school-based drug education. *Br J Addict* 1991;86:1099-109.
- [128] Tobler NS. Meta-analysis of 143 adolescent drug prevention programs: quantitative outcome results of program participants compared to a control or comparison group. *J Drug Issues* 1986;16:537-67.
- [129] Martin MB, Anshel M. Attitudes of elite adolescent Australian athletes toward drug taking: implications

- for effective drug prevention programs. *Drug Educ J Aust* 1991;5:223-38.
- [130] Nicholson N, Wynd T, Sheehan M, Doyle P, Schonfeld C. Drug use in sport: a study of the knowledge and attitudes of a section of the Australian sporting community. Canberra: Australian Sports Drug Agency, 1992.
- [131] Goldberg L, Bosworth EE, Bents RT, Trevisan L. Effect of an anabolic steroid education program on knowledge and attitudes of high school football players. *J Adolesc Health Care* 1990;11:210-14.
- [132] Goldberg L, Bents R, Bosworth E, Trevisan L, Elliot DL. Anabolic steroid education and adolescents: do scare tactics work? *Pediatrics* 1991;87:283-6.
- [133] Goldberg L, Elliot D, Clarke G, MacKinnon D, Moe E, Zoref L, Green C, Wolf S, Greffarth E, Millar D, Lapin A. Effects of a multidimensional anabolic steroid prevention intervention. *JAMA* 1996;276:1555-62.
- [134] Schnirring L. Fortifying students against steroid use. *Phys Sports Med* 1996;24:15-16.
- [135] Australian Sports Drug Agency. Annual report 1991-92. Canberra: Australian Government Publishing Service, 1992.
- [136] Australian Sports Drug Agency. Annual report 1994-95. Canberra: Australian Government Publishing Service, 1995.
- [137] Pope HG, Katz DL, Champoux R. Anabolic-androgenic steroid use among 1,010 college men. *Phys Sports Med* 1988;16:75-81.
- [138] Coomber R. Drugs in sport: rhetoric or pragmatism. *Int J Drug Policy* 1994;4:169-78.
- [139] Black T. Why banning drugs in sport does more harm than good. *Policy* 1993;9:8-10.