

**Briony Larance, Louisa Degenhardt, Paul  
Dillon and Jan Copeland**

**Use of performance and image enhancing  
drugs among men: a review**

**NDARC Technical Report No. 232**



**USE OF PERFORMANCE  
AND IMAGE ENHANCING  
DRUGS AMONG MEN:  
A REVIEW**

**2005**

**Briony Larance, Louisa Degenhardt (PhD),  
Paul Dillon and Jan Copeland (PhD)**

National Drug and Alcohol Research Centre  
University of New South Wales

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# Glossary of terms

## *Anabolic*

Refers to substances that promote the building up of a mass (in this report, the context is usually body mass) from its constituent elements (e.g. proteins and amino acid).

## *Catabolic*

Refers to substances that promote the breaking down of mass (in this report, the context is usually body fat) to its constituent elements.

## *Performance and image enhancing drugs (PIEDs)*

'PIEDs' refers to those substances that are used to enhance sporting performance (e.g. improving strength and/or endurance), mask the use of performance-enhancing drugs to avoid drug testing, improve the body's appearance (e.g. increasing muscle size and/or reducing body fat), and to manage the side effects of AAS use.

## *AAS*

Anabolic androgenic steroids are synthetic hormones that imitate male sex hormones (androgens) in the body. They can influence the development of primary and secondary sex characteristics such as body hair, deepening of the voice, development of the male sex organs and sex drive ('androgenic effects') as well as influencing the development of lean body mass ('anabolic' effects).

## *Ergogenic*

Refers to those substances that increase the body's capacity for physical or mental work output. In the context of sports, ergogenic substances may give a competitive edge.

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# 1. Introduction

Although physical training remains the primary way of changing and developing appearance, there is a range of substances being used by some to enhance the effects of training. Performance and Image Enhancing Drugs (PIEDs) refer to substances that are generally used to enhance muscle growth ('anabolic' effects) or to reduce body fat ('catabolic effects'). The expected benefits of using these types of substances range from increasing the size and definition of muscles, reducing water retention and body fat, to increasing physical strength and endurance (Bahrke & Yesalis, 2004). The major substances of concern are human and veterinary anabolic-androgenic steroids (AAS), growth hormone, other reproductive hormones, diuretics, stimulants, beta-2 agonists (e.g. clenbuterol), creatine monohydrate, and hormones such as insulin and thyroxine (Henry-Edwards, 2004). The most commonly used PIEDs are AAS.

The widespread use of the term 'performance and image enhancing drugs' (PIEDs) has evolved over the last 5 years in Australia. Originally, 'performance-enhancing drugs' (PEDs) was the term used to describe the range of substances that could have performance benefits for athletes. 'PEDs' is a term that is still widely used in the US, even where there is no direct link to competitive sports. Several Australian reports have identified that the use of AAS and related substances affect not only the sporting sector, but also a wider cross-section of the Australian community (Australian Olympic Committee, 2000; Henry-Edwards, 2004; Henry-Edwards, Ali, Bisshop, Gordon, & Hall, 1999). Accordingly, the use of the term 'PIEDs' has become the preferred term in Australian policy.

The present paper focuses primarily on the non-sporting use of PIEDs. Although athletes might be the most visible group (due to media attention) it has been hypothesised that they are actually the smallest group of PIEDs users (Bahrke & Yesalis, 2004; Shapiro, 1994). Other groups of PIEDs users have been identified in the literature including medical users, body image users, occupational users, and adolescents (Henry-Edwards, 2004; Peters, Copeland, Dillon, & Beel, 1997).

Use of PIEDs often occurs without medical supervision, and in amounts that greatly exceed recommended therapeutic doses. Assessing the health risks can be difficult as users often take complex combinations of drugs. While a small proportion of PIEDs are prescribed by a doctor for therapeutic reasons, many of the substances used in Australia are believed to be obtained and used illicitly, and there is an active black market for PIEDs (Australian Crime Commission, 2003).

## 2. Performance and image enhancing drugs: perceived benefits and potential harms

Drug testing in sport has given rise to an increasingly sophisticated range of performance-enhancing drugs and masking agents that are being used by both elite sportspeople and other PIEDs users.

In Australia, the range of PIEDs that are available tend to include over-the-counter food supplements, medicines that are commercially produced for human use, medicines that are commercially produced for veterinarian use and substances that are illicitly produced (Campbell, 2001: cited by (Australian Crime Commission, 2003). Many of these are prescription-only medications that have been diverted to the black market. The table below gives an indication of the wide range of substances that could potentially be used to enhance performance and image.

**Table 1: Drugs and substances used to enhance performance and appearance**

|                                    |  |
|------------------------------------|--|
| Amino acids/protein powders        | Ginseng                                |
| Amphetamines/stimulants            | Gonadotrophin-releasing hormone (GNRH) |
| Anabolic-androgenic steroids (AAS) | Human Chorionic Gonadotrophin (HCG)    |
| Androstenedione                    | Human Growth Hormone (HGH)             |
| Anti-inflammatories                | Insulin-like Growth Factor (IGF-1)     |
| Boron                              | Marijuana                              |
| Chromium picolinate                | Methcathinone                          |
| Clenbuterol                        | Minerals                               |
| Creatine                           | Oil of Evening Primrose                |
| Cyproterone acetate                | Perfluorocarbon                        |
| DHEA (dehydroepiandrosterone)      | Smilax                                 |
| Diuretics                          | Tamoxifen                              |
| Drug testing/masking agents        | Thyroid hormone                        |
| Ephedrine                          | Tribestan                              |
| Erythropoietin (EPO)               | Vanadyl Sulfate                        |
| Gamma Hydroxybuterate (GHB)        | Vitamins                               |
| Glandular extracts                 |  |

Source: Yesalis and Bahrke (2000: p.26)

*Note: Some of these substances, such as tamoxifen and HCG, are used to treat the adverse effects of AAS abuse. In addition, not all substances listed have been demonstrated to enhance performance or appearance.*

Although this paper addresses the main PIEDs of concern (hGH, hCG, clenbuterol, anti-oestrogens, prohormones, creatine monohydrate, etc), the discussion focuses predominantly on AAS. Of all PIEDS, AAS are most frequently investigated in the literature and there is a growing body of evidence regarding patterns of use and effects. AAS also remain the primary way that people change their appearance if they choose to use drugs to do so (Evans, 2004). There is very little (if any) scientific literature on the non-medical use, effects and harms of other PIEDs.

## 2.1. Anabolic-androgenic steroids (AAS)

Androgens are the male sex hormones responsible for the primary and secondary sex characteristics of adults such as body hair, deepening of the voice, development of the male sex organs and sex drive. AAS are synthetic derivatives of testosterone originally developed to treat medical conditions.

The brand-names of injectable human AAS most commonly used in Australia include: Deca-Durabolin®; Sustanon®; Primobolan Depot®; Delaxestral®; and Testax®. The most commonly used human oral AAS include: Anapolan®; Andriol®; Primobolan®; Proviron®; Anavar®; and Orabolin®. Commonly used veterinarian AAS include: Spectriol®; Stanosus®; Testosus®; Drive®; Stanazol®; Banrot®, Finiject®, Equipose®, and Winstrol® (Campbell 2001: cited by Australian Crime Commission, 2003). Table 2 (below) presents the most commonly used AAS by chemical name.

| Table 2: Anabolic-androgenic steroids in common use |   |
|---|---|
| <i>Oral agents (17alpha-alkyl derivatives)</i>      | <i>Injectable Agents (17beta-ester derivatives)</i>                     |
| Methandrostenolone                                  | Testosterone esters: blend, cypionate, enanthate, heptylate, propionate |
| Methyltestosterone                                  | Nandrolone esters: decanoate, phenpropionate                            |
| Oxandrolone   | Boldenone   |
| Oxymetholone  | Methenolone   |
| Stanozolol  | Trenbolone  |
| Ethylestrenol                                       | Stanozolol  |
| Fluoxymesterone                                     | Dromostanolone  |
| Danazol   |   |

Source: Evans (2004: p.535)

All of the drugs listed above possess both anabolic and androgenic properties. ‘Anabolic’ properties relate to the ability to enhance muscle growth. None of the drugs currently available are purely anabolic – all AAS are virilising if administered for long enough at high enough doses. The anabolic:androgenic ratio of the different drugs does vary. However, our current knowledge is based on data developed in the 1950s and 1960s with limited clinical value (Kuhn, 2002). No further investigations of the relative anabolic/androgenic properties have been conducted using more modern tools to assess androgen receptor activity since the 1970s (Kuhn, 2002).

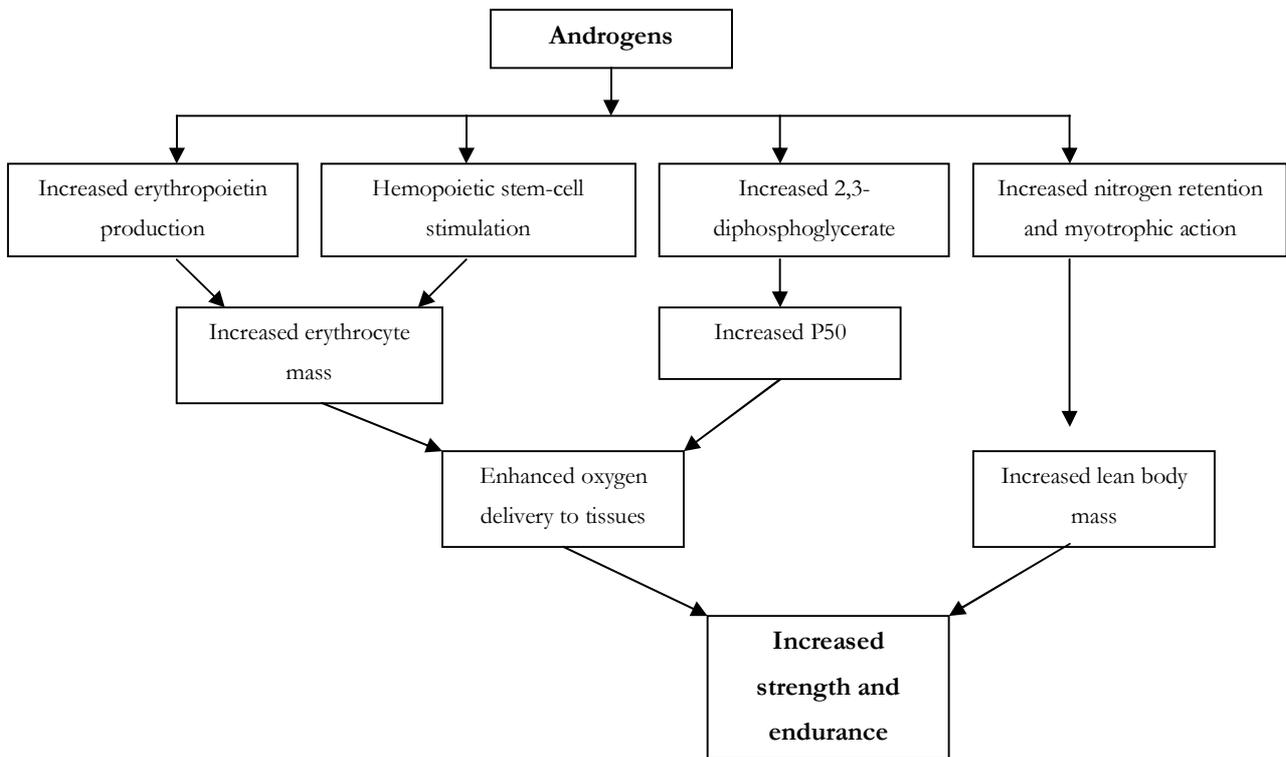
### **2.1.1. Medical application**

AAS were developed in the late 1930s to treat hypogonadism, a condition in which the testes do not produce enough testosterone for normal growth, development and sexual functioning (i.e. they exert ‘androgenic’ effects). During the 1930s scientists discovered that AAS could assist in the growth and repair of tissues, mainly skeletal muscles (‘anabolic’ effects) and bones. AAS have since been found to have positive benefits to a wide variety of patients. They have been prescribed to restore hormone levels in hypogonadal men, increase body weight and muscle mass in wasting syndromes such as in infection with HIV, improve bone density, improve tissue regeneration in severe burns and to treat depression (Bahrke & Yesalis, 2004; Evans, 2004; Kicman & Gower, 2003).

### **2.1.2. Perceived benefits of non-medical use**

The ergogenic benefits of androgens led to their use first by bodybuilders and weightlifters and then by athletes in other sports (National Institute on Drug Abuse, 2000). For a long time, the anabolic effects of AAS have been questioned, but recent investigations have confirmed the anabolic efficacy of these substances. There is a growing body of evidence that AAS have positive anabolic actions on the musculoskeletal system, influencing lean body mass, muscle size, erythropoiesis, strength, protein metabolism, bone metabolism, and collagen synthesis (Bahrke & Yesalis, 2004; Evans, 2004; Kuhn, 2002; Shahidi, 2001). The main beneficial actions of AAS are summarised below in Figure 1.

**Figure 1: The combined effect of androgens on the oxygen delivery system and muscle mass**



P50 is the oxygen pressure at which 50% of haemoglobin is oxygen saturated under normal physiologic conditions.

Source: Shahidi (2001: p.1366)

### **2.1.3. Potential physical harms**

Historically, the physical harms and negative side effects of AAS use have been overstated (Evans, 2004). Although AAS use has been associated (mainly through case reports) with several adverse and even fatal effects, the incidence of serious effects reported has been extremely low (Bahrke & Yesalis, 2004). Data from large, observational studies indicates that the majority of AAS users (88-96%) experience at least 1 minor, subjective physical side effect (Evans, 2004; National Institute on Drug Abuse, 2000; O'Sullivan et al., 2000; Peters, Copeland, & Dillon, 1999; Shahidi, 2001), most commonly including:

- Acne
- Reduction in testicular size
- Abnormal breast development (gynecomastia)
- Masculinisation in women and children
- Abnormal liver function (elevated enzymes)
- Injection site pain
- Alteration of blood constituents (lipids and coagulation factors)

Side effects seem to be dose-dependent. There is the possibility that non-medical megadoses of AAS could lead to serious and irreversible organ damage (Shahidi, 2001). However, the only physical complication that receives definitive support in the literature is unfavourable changes in the blood lipids (Bahrke & Yesalis, 2004; Thiblin & Petersson, 2004). Oral AAS in particular raise the levels of low-density lipoprotein (LDL) and decrease the levels of high-density lipoproteins (HDL). High LDL and low HDL levels increase the risk of atherosclerosis, a condition in which fatty substances are deposited inside arteries and disrupt blood flow, increasing risk of heart attack and stroke.

**Table 3: Side effects of anabolic-androgenic steroids**

**Physical:**

**Cardiovascular**

- Elevated blood pressure
- Decreased high density lipoprotein (HDL)
- Increased low density lipoprotein (LDL)
- Elevated red blood cell count (erythrocytosis)
- Heart disease (cardiomyopathy)
- Enlargement of the heart (myocardial hypertrophy)
- Arrhythmia
- Thrombosis

**Hepatic**

- Abnormal liver function (hepatotoxicity)
- Jaundice
- Neoplasia

**Dermatologic**

- Acne
- Abnormal breast development (gynaecomastia)
- Stretch marks (striae)
- Hair loss (alopecia)

**Reproductive-endocrine**

- Disruption of hormonal cycles
- Libido changes
- Subfertility
- Decreased luteinising hormone and follicle-stimulating hormone

**Male-specific**

- Decreases in testicular size
- Impaired sperm production (spermatogenesis)
- Impotence
- Prostate hypertrophy

**Female-specific**

- Masculisation/ hirsutism
- Voice deepening
- Menstrual irregularities
- Clitoral enlargement
- Reduced breast size

**Child-specific**

- Premature epiphyseal closure
- Precocious puberty

**Injection related**

- Bruising
- Infection (e.g. BBVI)
- Fibrosis
- Neuro-vascular injury

**Behavioural:**

- Mood swings
- Aggression (“roid rage”)
- Mania
- Depression
- Withdrawal
- Dependence

Source: ((Evans, 2004; Fudala, Weinrieb, Calarco, Kampman, & Boardman, 2003; National Institute on Drug Abuse, 2000; O'Sullivan et al., 2000; Peters et al., 1999; Shahidi, 2001; Wu, 1997)

In clinical and laboratory trials, AAS use has been associated with changes in the risk factors for cardiovascular disease, liver tumours, infertility, and other organs and functions. While the evidence is less conclusive, there are other areas of concern including cardiomyopathy, coronary artery disease, cerebrovascular accidents, prostatic changes and immune functions (Bahrke & Yesalis, 2004; Evans, 2004; O'Sullivan et al., 2000).

Many of these negative effects may be temporary (while on a cycle) and may be reversible following an AAS-free period. However, others may be permanent. Examples of irreversible changes include the virilising effects on women and children. One study found that several years after discontinuation of AAS use, strength athletes will show a slight concentric left ventricular hypertrophy in comparison with AAS-free strength athletes (Urhausen, Albers, & Kindermann, 2004).

Although studies have tried to monitor naturalistic (i.e. real life) patterns of AAS use (e.g. Fudala et al., 2003; O'Sullivan et al., 2000), the long-term health effects relating to the type of AAS, dose, frequency of use, age at initiation and concurrent drug use have not been conclusively established. The fact that individual patterns of use vary widely, that individuals may use large doses for prolonged periods of time, or that individuals may use other PIEDs (or other illicit drugs) in conjunction with AAS makes the conclusive assessment of health risks difficult.

The absence of long-term prospective data (especially regarding the naturalistic patterns of use) also makes judgements of safety uncertain. For example, AAS users believe that the method of cycling (using for a period of time, followed by a 'rest' period) reduces the risk of adverse effects, although there have not been longitudinal studies to confirm this.

Research in Sweden has been examining the morbidity and mortality rates among AAS users (e.g. Petersson, Garle, Granath, & Thiblin, 2005; Petersson, Garle, Holmgren et al., 2005). One study examined patient care records and compared the diagnoses and mortality rates of those patients who had tested positively for the presence of AAS and those patients who had tested negatively (Petersson, Garle, Granath et al., 2005). The study found higher rates of mortality among AAS-positive patients even when controlling for referral source, age and sex distribution. Substance use disorders, psychiatric disorders, central thoracic pain and unspecified convulsions also occurred more frequently among AAS-positive patients than AAS-negative patients. The authors concluded that their findings of increased rates of central thoracic pain and unspecified convulsions among AAS-positive were not conclusive (Petersson, Garle, Granath et al., 2005). However, their finding of higher rates of substance use and psychiatric disorders among AAS-positive patients is well supported elsewhere in the literature (see section 2.1.4).

Other physical health concerns relate to the route of administration of AAS. Injecting is known to carry health risks such as potential HIV transmission, hepatitis B, hepatitis C, and a range of bacterial infections.

An Australian study of AAS injectors (n=63), found that 9.5% of blood samples contained hepatitis C virus antibodies and 12% tested positive for hepatitis B core antibody (Aitken, Delalande, & Stanton, 2002). Both hepatitis B and hepatitis C virus exposure was associated with factors other than AAS-injecting (such as other injecting drug use and past imprisonment). While the rates of hepatitis C exposure among this sample were lower than normally found among other injecting drug users, there was evidence of AAS-related and other risk factors that could spread the virus among this group.

Some of the documented risk behaviours include sharing needles, sharing containers, dividing drugs using syringes, injecting others, injecting other illicit drugs, re-using needles and increased sexual risk-taking (e.g. engaging in sex with more than one partner while infrequently using condoms) (Aitken & Delalande, 1999; Aitken et al., 2002; Best & Midgley, 1998; Bolding, Sherr, Maguire, & Elford, 1999; Delalande, Aitken, Mercuri, & Stanton, 1998; Midgley et al., 2000).

#### **2.1.4. Potential psychological harms**

Like the physical side effects of AAS, it is difficult to clearly identify the psychological effects. Naturalistic patterns of use vary widely (from the dose, number/types of different AAS used and the length of use) and there is a range of different PIEDs that are often used in conjunction that may also have an effect on mood or behaviour (such as ephedrine, beta-agonists and insulin).

There are a number of general psychological effects that could be taking place relating to the use of AAS. There is the physical feedback the user receives in the form of a larger physique, and possibly improved performance. There are changes in the expectations of peers and self in relation to having a larger physique. There are the additional effects of AAS on mood and behaviour (Riem & Hursey, 1995). The contributions of these individual effects to overall behaviour and psychological wellbeing are extremely difficult to determine. To date, international studies have examined psychiatric disorders, aggression and violence, reinforcement and dependence.

The early effects of AAS use are seen as changes in mood and euphoria: users report an increase in confidence, energy and self-esteem, with enhanced motivation and enthusiasm. There is also diminished fatigue, sleeplessness and an ability to train through pain (Corrigan, 1996; Peters et al., 1999). Libido may be decreased, but is more often increased, sometimes markedly (Corrigan,

1996). These effects on mood are further supported by the findings that testosterone replacement therapy may produce anti-depressant effects in depressed men with low testosterone levels (Pope, Cohane, Kanayama, Siegel, & Hudson, 2003).

Among psychiatric disorders, randomised controlled studies have confirmed hypomania, increased aggressiveness and depression in some, but not all, trials of AAS (Maycock & Beel, 1997; Pope, Kouri, & Hudson, 2000; Thiblin & Petersson, 2004). These findings are also supported by case studies in the literature. Problems are most likely to be experienced during the 'on' cycles (the periods where AAS are being taken) as opposed to rest periods in between cycles. The literature supports that individuals experience more irritability, more enthusiasm, increased sexual excitability, and heightened tendencies towards aggression with AAS use (Bahrke & Yesalis, 2004; Clark & Hendersen, 2003; Corrigan, 1996; Daly et al., 2003; Evans, 2004; Maycock & Beel, 1997; H. G. Pope et al., 2000; Riem & Hursey, 1995). Individuals may also experience depression and lower or more variable sex drive following cessation of AAS use (Riem & Hursey, 1995).

'Roid rage' is a common street term for uncontrollable anger relating to AAS use. Although not clinically recognised, it is a term that is popularised by the media. Corrigan (1996: p.3) describes 'roid rage' as when 'aggressive feelings increase to the extent that violent, hostile, antisocial behaviour develops'. AAS use has been implicated in the perpetration of property damage, self-injury (including reckless driving or crashing cars), assaults, marriage break-ups, domestic violence, child abuse, suicide, planned violent crime and attempted murder or murder (Corrigan, 1996; Peters et al., 1999; Thiblin, 1999). It is not the case, however, that all AAS users are violent offenders.

The Australian Institute of Criminology led a paper examining the links between aggressive and self-harmful behaviour and a range of social, health and legal factors. In this paper (McDonald & Brown, 1997), the expert working group identified a number of key risk factors for aggressive and self-destructive behaviour:

- Having a history of violent behaviour;
- Being male;
- Being a young adult;
- Having experienced difficulties in childhood, including inadequate parenting, troubled relationships within the family and low levels of school achievement;

- Having problems of psychotropic substance abuse, especially problematic alcohol use;
- Having a severe mental illness the symptoms of which are not being adequately controlled through therapeutic regimes; and
- Being in situations conducive to self-directed or interpersonal violence, including having access to firearms.

In summary, the determinants of violence are varied and complex interactions between individual and environmental characteristics.

The complex interaction between psychosocial influences and pharmacological effects is also demonstrated by retrospective autopsy protocol study of 52 deceased AAS users in Sweden (Petersson, Garle, Holmgren et al., 2005). The AAS users were compared to 68 deceased users of amphetamine and/or heroin who were AAS-negative. AAS users died at a significantly younger age than users of heroin and/or amphetamine, and they died significantly more often from homicide or suicide than users of other drugs. The authors concluded that AAS users may be more likely to become involved in incidents leading to violent death.

In a review examining the relationships between AAS use and aggression levels, Maycock & Beel (1997) found that the majority of studies appear to have found at least some evidence of an association between AAS use and aggression. Where studies found little or no relationships with aggression, the doses of AAS were generally smaller (e.g. Tricker et al., 1996). With larger doses, or after taking AAS for a longer time, there is a loss of inhibition and a lack of judgement, often accompanied with mood swings or grandiose ideas (Bahrke & Yesalis, 2004; Corrigan, 1996). It is likely that chronic high doses are more likely to increase the risk of aggressive and/or violent behaviour than to leave it unaffected (Daly et al., 2003; Maycock & Beel, 1997).

The way in which AAS use increases aggression is unclear, and it is possible that AAS use only produces aggression or violence in persons already predisposed. At least some of the aggressive behaviour shown by those who use AAS could be produced by psychosocial influences rather than by the pharmacological effects of the drugs themselves (Maycock & Beel, 1997). Environment also plays a role. There is nearly always an external trigger, and 'rage' usually occurs in situations where aggressive behaviour is known to manifest such as driving a car or domestic situations (Peters et al., 1997).

There are also methodological problems with the studies of AAS and aggression. For example, studies often fail to control for the variation in naturalistic doses, other illicit drug use, the

variability between classes of AAS and baseline aggression levels. In addition, the experimental measures of aggression may not apply to the real world (Maycock & Beel, 1997).

Animal studies have confirmed relationships between increased testosterone and aggression and sexual behaviour in rats, and have also examined the effects on reward, learning and memory (eg: Clark & Hendersen, 2003; McGinnis, 2004). Wood (2004) argues that, in a natural environment, testosterone secretion is related to reinforcing social behaviours (such as mating and aggression). Although it is difficult to separate out the psychological and physiological actions of AAS, it is also possible that testosterone is reinforcing (i.e. intrinsically rewarding) independent of social behaviour. Although the addiction potential for testosterone is not comparable to that of highly addictive drugs such as cocaine or opiates, it is proposed that the potential for addiction is similar to mild reinforcers such as caffeine (Wood, 2004). There is also evidence that AAS may potentiate the effects of other illicit drugs such as amphetamines (eg: Clark & Hendersen, 2003) and cocaine (e.g. Togna, Togna, Graziani, & Franconi, 2003).

Brower (2002: cited by Wood 2004) proposes a 2-stage model of dependence, where the anabolic effects of AAS account for the first stage of AAS use. However, with chronic exposure, users can develop physical and psychological dependence on AAS. Copeland, Peters and Dillon (2000) examined the occurrence of DSM IV symptoms of AAS abuse and dependence in a sample of Australian AAS users. Over three quarters (78%) of the sample exhibited at least one symptom of abuse or dependence on AAS. 23% of the sample qualified for a diagnosis of AAS dependence using DSM IV criteria, and 25% met criteria for AAS abuse. The only variable related to an AAS substance use disorder was reporting the experience of AAS-related aggression, which the authors suggested may be a useful clinical indicator of the disorder (Copeland, Peters, & Dillon, 2000).

#### **2.1.5. Legal issues**

It is illegal to possess AAS without a prescription in Australia. AAS are banned under the Olympic Movement's *World Anti-Doping Code Prohibited Classes of Substances and Prohibited Methods* (2005).

## **2.2. Anti-oestrogenic agents**

Anti-oestrogenic agents are medications that either block the actions of oestrogen by occupying the oestrogen receptors on cells (e.g. tamoxifen), or reduce the amount of circulating oestrogen (e.g. ‘aromatase inhibitors’). Aromatase inhibitors work by keeping androgens from being converted to oestrogen.

The main substances of concern include tamoxifen (Nolvodex®), and aromatase inhibitors such as anastrozol (Arimidex®), exemestane (Aromasin®), and letrozole (Femara®).

### **2.2.1. Medical applications**

Most of the above substances are legitimately used in the hormonal treatment of breast cancers.

### **2.2.2. Perceived benefits**

Anti-oestrogenic agents are being used by men to counteract the undesirable side effects of AAS use. Most commonly, these substances are used to prevent gynaecomastia (development of the breast tissue). Users also believe that tamoxifen might increase the ‘hardness’ and definition of muscle.

Anti-oestrogenic agents are not likely to increase performance or enhance muscle size, but they are used to enhance appearance through the management of unwanted physical side effects.

### **2.2.3. Potential harms**

There are no studies of the non-medical use of anti-oestrogens by AAS users in the scientific literature, making judgements of efficacy and safety difficult. It is likely that concurrent use of AAS and anti-oestrogens further suppresses natural hormonal function, the consequences of which are not fully understood.

Reported side effects of these substances include hot flushes, gastro-intestinal disorders, fluid retention and venous thrombosis (Australian Sports Drug Agency, 2005).

### **2.2.4. Legal issues**

It is illegal to use tamoxifen or aromatase inhibitors without a prescription. Anti-oestrogenic agents are banned for non-medical purposes under the Olympic Movement’s *World Anti-Doping Code Prohibited Classes of Substances and Prohibited Methods (2005)*.

## **2.3. Clenbuterol**

Clenbuterol is classed as a 'beta-2 agonist' and its short-term effects are similar to stimulant drugs like amphetamine or ephedrine (i.e. increases heart rate, temperature, perspiration and blood pressure).

### **2.3.1. Medical application**

The main therapeutic use of clenbuterol is in the treatment of asthma to relax the smooth muscle in the airways. However, clenbuterol is not approved for human use in Australia (Kennedy, 2000). Clenbuterol is used as a bronchodilator in veterinary medicine in Australia.

### **2.3.2. Perceived benefits**

Clenbuterol is being used alone and in conjunction with other substances to promote the growth of skeletal muscle ('anabolic effects') and to reduce body fat ('catabolic effects'). Some animal studies have shown that clenbuterol has the 'anabolic effect' of increasing muscle mass and body weight by enhancing muscle protein synthesis in rodents (Boyce, 2003; Kennedy, 2000). However, no human studies are available on whether clenbuterol has a direct anabolic effect in humans.

Bodybuilders and athletes most often utilise clenbuterol as a 'fat burner' to 'define' muscles (i.e. for its 'catabolic effect'). Clenbuterol has the ability to slightly increase the body's core temperature and metabolism, which users believe assists in the burning of calories.

### **2.3.3. Potential harms**

The reported side effects of clenbuterol are similar to other CNS stimulants (e.g. tremors, palpitations, sleeplessness, nervousness and anxiety). If used at extremely high doses, there is the potential for adverse cardiovascular events (e.g. stroke) and fatal overdose. There is one reported case of myocardial infarction related to clenbuterol use in the literature (Goldstein, Dobbs, Krull, & Plumb, 1998) and two cases of accidental clenbuterol poisoning through ingestion of falsified 'Thai Dianabol' (van der Kuy, Stegeman, Looij, & Hooymans, 1997).

### **2.3.4. Legal issues**

Clenbuterol cannot be prescribed for human use in Australia and is a veterinary medicine only. It is banned under the Olympic Movement's *World Anti-Doping Code Prohibited Classes of Substances and Prohibited Methods* (2005).

## **2.4. Clomiphene (Clomid®)**

Clomiphene is a medication that is used in fertility treatment for women and men. While its actions are complex, clomiphene is usually classed as an anti-oestrogenic agent.

### **2.4.1. Medical applications**

In both men and women, clomiphene influences GnHR, FSH, LH and estradiol. In women, this treatment can trigger ovulation (production of a mature egg). In men, clomiphene is prescribed less frequently, but may be used where there is a low sperm count.

### **2.4.2. Perceived benefits**

Like hCG (discussed below), clomiphene is generally used to complement a cycle of AAS. The primary use of clomiphene among PIEDs users is to trigger natural testosterone production either during or following a long cycle of AAS. During long AAS cycles, the natural testosterone levels remain suppressed for a considerable period of time. By administering clomiphene, AAS users believe they can restore natural testosterone production. This is perceived as the main benefit of clomiphene. However, clomiphene is often used in this way without medical supervision. Due to its anti-oestrogenic properties, clomiphene is also used concurrently with AAS to prevent side effects such as gynecomastia.

### **2.4.3. Potential harms**

There are no studies of the non-medical use of clomiphene by AAS users in the scientific literature, making judgements of efficacy and safety of its use in this way difficult.

The known side effects of clomiphene treatment include hot flashes, blurred vision, dizziness, nausea, bloating and headache.

### **2.4.4. Legal issues**

It is illegal to use clomiphene without a prescription. Anti-oestrogenic agents are banned for non-medical purposes under the Olympic Movement's *World Anti-Doping Code Prohibited Classes of Substances and Prohibited Methods (2005)*.

## **2.5. Creatine Monohydrate**

Creatine is a naturally occurring compound synthesised from amino acids by the kidneys and liver. Creatine is also contained in foods such as meat, fish and poultry. Creatine monohydrate is the most commonly used salt form of synthetic creatine. Creatine monohydrate is simply a molecule of creatine accompanied by a molecule of water for added stability.

### **2.5.1. Perceived benefits**

Using creatine monohydrate may replenish and increase the energy stores to delay fatigue during intense, brief exercise, as well as reduce recovery time between bouts of exercise (Brodie & Towse, 1999; Chyka, 2003; Tokish, Kocher, & Hawkins, 2004). Research in this area seems to support the theory that creatine may benefit certain athletes in certain situations.

It is not clear whether creatine plays any direct role in protein-synthesis (increasing muscle mass). It is more likely to have an indirect role in increasing muscle mass through supplementing muscle energy during training (Mendes, Pires, & Oliveira, 2004; Paddon-Jones, Borsheim, & Wolfe, 2004; Volek et al., 2004).

### **2.5.2. Potential harms**

The potential side effects of long-term use are unknown. Since creatine is cleared by the kidneys and excreted in the urine, there may be effects on renal function (especially in those with impaired renal function) (Paddon-Jones et al., 2004). Creatine can affect fluid balance, which might contribute to muscle cramps and heat illness (Paddon-Jones et al., 2004). While studies have focused on the ergogenic effects of creatine supplementation for athletes, long-term studies into the long-term effects on muscles, kidneys and other organs have not yet been conducted. Similarly, these studies have been conducted with college-aged and adult athletes, but not adolescents. There is a lack of data regarding long-term effects of creatine use among adolescents.

An additional concern is that there is a risk of impurities or doses higher or lower than those on the labelling. Creatine is not subject to the same quality control standards as pharmaceuticals.

### **2.5.3. Legal issues**

Creatine monohydrate is classified as a nutritional supplement, not a pharmaceutical grade drug. Creatine monohydrate is available commercially in Australia.

## **2.6. Dehydroepiandrosterone (DHEA) and Androstenedione**

DHEA is a weak androgen that is secreted by the adrenal gland. It is one of the main precursors in the production of male and female sex hormones. Androstenedione is an AAS produced either by the gonads and adrenal glands, or from DHEA by peripheral transformation. DHEA and androstenedione are often described as 'prohormones' or 'hormone precursors' (Australian Crime Commission, 2003; Bahrke & Yesalis, 2004; Boyce, 2003; Corrigan, 1999).

Synthetic forms of both DHEA and androstenedione are produced as tablets, capsules, patches, gels, creams and sprays.

### **2.6.1. Medical applications**

Neither DHEA nor androstenedione have clinical applications, and they are not approved for medical use in Australia.

### **2.6.2. Perceived benefits**

Circulating levels of DHEA peak in early adulthood and then decline with age. Accordingly, there has been aggressive marketing of DHEA as an 'anti-ageing' and 'anti-obesity' supplement also capable of improving libido, wellbeing and the immune system (Bahrke and Yesalis, 2004). DHEA is also being used to enhance levels of androgens such as androstenediol and testosterone in order to improve performance or enhance physique. Competitive athletes may be using DHEA as a difficult-to-detect means of increasing testosterone levels (Bahrke & Yesalis, 2004; Corrigan, 1999). However, DHEA studies are limited. DHEA has not been shown to exert effects on serum testosterone, body fat and strength in humans (Bahrke & Yesalis, 2004; Kicman & Gower, 2003; Morales, Nolan, Nelson, & Yen, 1994), although it may have some effects on IGF-1 levels when given at replacement doses in older men and women (Morales et al., 1994).

Androstenedione is marketed to increase blood testosterone concentrations for the purposes of increased strength, lean mass and sexual performance (Bahrke & Yesalis, 2004). It is a relatively weak AAS whose anabolic activity is one-fifth to one-tenth that of testosterone (Bahrke & Yesalis, 2004). Some studies have shown androstenedione supplementation increased serum testosterone levels, whereas others have failed to demonstrate this effect (Bahrke & Yesalis, 2004). To date, studies have failed to show positive effects on strength or lean muscle mass from androstenedione supplementation. It should be noted that the studies that have been conducted have administered doses equal to those recommended by the supplement

manufacturers and it is likely that naturalistic doses exceed these amounts. Research has not been conducted with larger (supra-physiological) doses and there are no published reports on the anabolic efficacy of androstenedione (Kuhn, 2002).

In summary, there are mixed findings in the scientific literature regarding the effects of DHEA and androstenedione on serum testosterone levels, body fat and lean muscle mass, but to date, most research does not support demonstrable anabolic effects from either substance.

### **2.6.3. Potential harms**

In women, owing to the androgenic effects of both DHEA and androstenedione there is a risk of virilizing effects such as hirsutism and acne (Bahrke & Yesalis, 2004). In men, the increased levels of androstenedione are accompanied not only by increased testosterone levels but also by increased production of estrogens, increasing the risks of feminising effects such as gynecomastia (Bahrke & Yesalis, 2004; Kuhn, 2002).

Adverse effects of both DHEA and androstenedione have not been thoroughly investigated in young and middle-aged men, only ageing men. Both DHEA and androstenedione have been shown to adversely affect blood lipid levels through a significant reduction in high-density lipoprotein cholesterol (HDL-C). This reduction in HDL-C is highly consistent with findings from numerous studies into the effects of AAS on blood lipid levels (Bahrke & Yesalis, 2004; Kuhn, 2002). Oral androstenedione at high doses may also affect liver structure and function (Bahrke & Yesalis, 2004).

The quality control of nutritional supplements is a concern, as different brands vary widely in terms of labelled strength (Boyce, 2003).

The long-term health effects of prolonged supplementation with DHEA, androstenedione and related substances are unknown, especially when used in large doses in conjunction with other performance-enhancing substances.

### **2.6.4. Legal issues**

In Australia, under Schedule 8 of the Customs (Prohibited Imports) Regulations, the importing of synthetic DHEA or androstenedione without a Commonwealth Government permit is prohibited (Australian Crime Commission, 2003; Corrigan, 1999). However, there were large increases in the proportions of DHEA seized at the border from 1996/97 to 2001/2002

(Australian Crime Commission, 2003). Both DHEA and androstenedione are banned under the Olympic Movement's *World Anti-Doping Code Prohibited Classes of Substances and Prohibited Methods (2005)*.

## **2.7. Erythropoietin (EPO)**

EPO is a naturally occurring hormone produced by cells in the kidneys that regulate the production of red blood cells in bone marrow. These kidney cells are sensitive to low blood oxygen content and will release EPO when oxygen is low. EPO stimulates the bone marrow to produce more red blood cells (to increase the oxygen carrying capacity of the blood) (Tokish et al, 2004; Boyce, 2003).

### **2.7.1. Medical applications**

Artificial EPO (r-HuEPO) was designed to help people with kidney diseases who were chronically anaemic. r-HuEPO clearly enhanced aerobic capacity in these patients. Since then it has been used to help treat people with cancer, and HIV patients who are undergoing debilitating AZT treatment.

### **2.7.2. Perceived benefits**

The use of EPO is believed to increase oxygen absorption, reduce fatigue and improve endurance by increasing the rate of red cell production (Boyce, 2003). It is also believed that EPO increases the metabolism and the healing process of muscles because the extra red cells may carry more oxygen and nutrients. Unlike other PIEDs, EPO has limited or no application to enhancing body image. People are using EPO to enhance performance in elite endurance sports (Tokish et al, 2004; Boyce, 2003; Kennedy, 2000).

### **2.7.3. Potential harms**

There are harms associated with artificially raising haemoglobin levels. Raising the haematocrit level (the level of circulating red blood cells) can lead to increased viscosity (or thickening) of the blood. This in turn increases the risks of thrombosis and myocardial infarction. These life-threatening conditions can be further exaggerated by the dehydration that occurs in training and endurance sports. While not directly proven to be due to EPO use, between 1997 and 2000, 18 cyclists have died from stroke, myocardial infarction or pulmonary embolism (Tokish et al., 2004)

Other possible problems could include rapid increases in blood pressure and liver or pancreatic damage.

There are also those risks associated with injecting – bruising, infection (e.g. BBV), fibrosis, neuro-vascular injury.

#### **2.7.4. Legal issues**

It is illegal to possess or use EPO without a prescription in Australia. Use of EPO for non-medical purposes is banned under the Olympic Movement's *World Anti-Doping Code Prohibited Classes of Substances and Prohibited Methods (2005)*.

### **2.8. Human Chorionic Gonadotrophin (hCG)**

Human Chorionic Gonadotrophin (hCG) is a naturally occurring hormone produced in the placenta of women during pregnancy. It is important in triggering hormonal changes in women during pregnancy and embryo development. It also has medical applications for men.

The most common brand name of hCG used in Australia is Pregnyl®.

#### ***Medical applications***

hCG has been used in the treatment of delayed puberty in boys (where boys do not develop secondary sexual characteristics at the normal age of 12-14 years old), female infertility (hCG stimulates ovulation), low sperm count (oligospermia) and undescended testes. When taken by males, hCG can stimulate the testes to produce testosterone rapidly (Coviello et al., 2005).

There are case reports of hCG being prescribed to bodybuilders in the treatment of hypogonadism and azoospermia that did not reverse upon ceasing AAS use (Mernon, 2003).

#### **2.8.1. Perceived benefits**

Taken for non-medical purposes, hCG is generally used to complement a cycle of AAS. The primary use of hCG among bodybuilders and others is as part of post-cycle recovery, to 'kickstart' natural testosterone production following a long cycle of AAS. During long duration AAS cycles, the natural testosterone levels stay suppressed for a considerable time, causing atrophy of the testes. By administering hCG, AAS users believe they can bring back the size of

the testes and natural testosterone production. This is perceived as the main benefit of hCG. However, hCG is often used in this way without medical supervision.

### **2.8.2. Potential harms**

hCG can increase testosterone levels, so the side effects are likely to be similar to those of AAS, including the risk of gynecomastia. However, there is very little in the scientific literature on the non-medical use of hCG in men. It is possible that use of hCG may further suppress the body's natural hormone functioning.

### **2.8.3. Legal issues**

It is illegal to use hCG without a prescription in all parts of Australia. hCG is banned for men under the Olympic Movement's *World Anti-Doping Code Prohibited Classes of Substances and Prohibited Methods (2005)*, but is allowed for women. hCG is not banned in female athletes because it would not lead to muscle development and might occur naturally in high levels if the athlete is pregnant.

## **2.9. Human Growth Hormone (hGH)**

hGH is a naturally occurring hormone produced by the pituitary gland and is one of the most important hormones influencing growth and development in humans. hGH plays a major role in normal growth from birth to adulthood. It stimulates the liver and other tissues to secrete insulin-like growth factor (IGF-1). IGF-1 stimulates production of cartilage cells, resulting in bone growth and also plays a role in muscle growth (Boyce, 2003; Rennie, 2003).

Low hGH levels in children and teenagers can result in dwarfism. Excessive hGH secretion in children (which is extremely rare and usually resulting from a tumour of the pituitary gland) can result in gigantism. In adults, some conditions (such as tumours) may cause excess secretion of hGH after puberty, and while this has little effect on skeletal growth, it can result in a condition known as acromegaly (abnormal growth of bones of the hands, feet and face) (Tokish et al., 2004).

### **2.9.1. Medical applications**

hGH has been used to treat deficiency disorders in children (such as Turner's syndrome). In adults, it has been prescribed where there is a growth hormone deficiency and a perceived impairment in quality of life (van der Lely, 2004). Before 1985, hGH was primarily obtained from the pituitary glands of cadavers. The development of Creutzfeldt-Jakob disease (a

degenerative brain disorder) in those who were treated with hGH produced in this way led to the discontinuation of all products derived from the human pituitary gland. This has led to development of artificial (recombinant) hGH (r-hGH).

### **2.9.2. Perceived benefits**

Despite its potentially serious side effects and lack of evidence of its efficacy, hGH is increasingly being used to enhance performance and appearance (van der Lely, 2004). The reported benefits of hGH as presented in internet marketing include: the reversal of common diseases associated with ageing, improved brain activity and function, strengthening connective tissue which reduces the probability of injury, weight loss without any loss in lean mass, reduction of wrinkles by rejuvenating the skin, increasing energy levels and brightening mood, promotion of muscle growth, improved libido, improved lung function, provision of immune system support and thymus function, and the ability to produce more individual muscle cells. There have been few clinical studies of these reported benefits of hGH supplementation.

Some individuals use hGH because they perceive that it is as effective as AAS with fewer side effects, and it was historically difficult to detect in a drug test (a test has since been developed). It is being used alone and in conjunction with other substances with the aim of achieving anabolic effects, reducing muscle cell breakdown and reducing body fat. However, the actual evidence that hGH is 'highly anabolic' in healthy adults is poor (Rennie, 2003). hGH appears to decrease body fat and may increase fat-free mass (Boyce, 2003; Ehrnborg, Ellegard, Bosaeus, Bengtsson, & Rosen, 2005; Kennedy, 2000; Tokish et al., 2004; van der Lely, 2004). However, there is less evidence that these effects translate to increased muscle strength, endurance and sporting performance (Ehrnborg et al., 2005; Rennie, 2003).

hGH does seem to have a 'repartitioning' effect, where muscle definition may be improved by decreasing subcutaneous fat. This may partly explain its popularity with bodybuilders (Rennie, 2003). It is also likely that hGH is used in conjunction with AAS, and very little is known about the combination of these substances. It is possible, for example, that there is a synergistic effect between hGH and AAS.

### **2.9.3. Potential harms**

The potential harms of non-medical hGH use are serious and potentially life threatening. The most common side effects reported on clinical trials include those related to fluid retention (such as swollen hands and feet) (Ehrnborg et al., 2005; Tokish et al., 2004). However, chronic hGH

use is very likely to lead to acromegaly, which in turn can shorten life expectancy and is likely to increase the risk of cardiac instability, hypertension, insulin resistance, type 2 diabetes, abnormal lipid metabolism, osteoarthritis, and breast and colorectal cancers (Ehrnborg et al., 2005; Rennie, 2003).

#### **2.9.4. Legal issues**

It is illegal to use hGH without a prescription in all parts of Australia. hGH is banned under the Olympic Movement's *World Anti-Doping Code Prohibited Classes of Substances and Prohibited Methods (2005)*.

### **2.10. Insulin-like Growth Factor (IGF-1)**

IGF-1 is a naturally occurring growth factor or hormone that stimulates many processes in the body. It is the hormone through which human growth hormone (hGH) exerts most of its growth promoting effects. IGF-1's chemical structure is similar to that of insulin, so in very high quantities it can produce the same effects as insulin (such as low blood sugar, or 'hypoglycaemia') (Kennedy, 2000).

#### **2.10.1. Medical applications**

Recombinant human IGF-1 (rhIGF-1) was produced for clinical use in the 1990s and, during this time, its effects on growth-promotion and insulin effects were closely studied. However, trials stopped following apparent links between high levels of IGF-1 and malignancy in the cohort studies. Since then, the situation has been reviewed and some clinical trials have resumed (Ranke, 2005). IGF-1 may have beneficial applications in the treatment of some growth disorders (e.g. Laron syndrome), diabetes mellitus and insulin resistance (Ranke, 2005).

#### **2.10.2. Perceived benefits**

Blood serum levels of IGF-1 have been found to increase with supraphysiological doses of hGH (Ehrnborg et al., 2005). However, it is widely assumed that athletes and others are supplementing IGF-1 directly (Kennedy, 2000). It is assumed that IGF-1 is being used alone and in conjunction with other substances to promote muscle growth ('anabolic effects') and to reduce body fat.

#### **2.10.3. Potential harms**

The most common side effect of IGF-1 supplementation is hypoglycaemia, which is potentially life threatening. Headaches and water retention are also reported (headaches may be from an

increase in cerebrospinal fluid and benign intracranial pressure). Other longer-term effects include parotidomegaly, facial pain, Bell's palsy and avascular necrosis of the femoral head (Kennedy, 2000). Some studies have shown an increased risk of malignancy, particularly in patients with acromegaly (Ranke, 2005).

#### **2.10.4. Legal issues**

It is illegal to use IGF-1 without a prescription in Australia. IGF-1 is banned under the Olympic Movement's *World Anti-Doping Code Prohibited Classes of Substances and Prohibited Methods* (2005).

### **2.11. Insulin**

Insulin is a naturally occurring hormone that is secreted by the cells of the pancreas in response to high blood sugar levels. When blood sugar is high, insulin is released to reduce glucose levels in the blood and prevent the liver from releasing additional glucose. Insulin plays a role in the metabolism of carbohydrates, fats and proteins.

#### **2.11.1. Medical applications**

Insulin is prescribed for the treatment of diabetes, and is administered to assist in the regulation of blood sugar.

#### **2.11.2. Perceived benefits**

Insulin is being used by bodybuilders to increase muscle bulk. The evidence appears to indicate that insulin does not play a role in protein synthesis directly. However, insulin may affect body composition by increasing muscle glycogen stores and by inhibiting muscle protein breakdown (Sonksen, 2001). It has long been known that insulin-treated patients with diabetes have an increased lean body mass when compared to matched controls (Sonksen, 2001). However, to date, there have not been any studies of the non-medical use of insulin among athletes or other groups.

#### **2.11.3. Potential harms**

The main side effect is hypoglycaemia, which can lead to tremors, confusion, coma and possibly death.

#### **2.11.4. Legal issues**

It is illegal to use insulin without a prescription. Insulin is banned for non-medical purposes under the Olympic Movement's *World Anti-Doping Code Prohibited Classes of Substances and Prohibited Methods* (2005). The legitimate use of insulin in sport to treat insulin dependent diabetes requires a therapeutic use exemption from a recognised therapeutic use exemption committee.

#### **2.12. Other dietary supplements**

Aside from the PIEDs discussed above, there is also a range of other over-the-counter dietary supplements. Dietary supplements are widely available and are used by a range of people interested in fitness and training. Many of these supplements are mislabelled and could contain AAS, prohormones or stimulants such as caffeine and ephedrine.

A Swiss study of 103 over-the-counter dietary supplements screened for the presence of stimulants and the main AAS parent compounds (Baume, Mahler, Kamber, Mangin, & Saugy, 2005). Three of the products contained an AAS – methandienone - in a very high amount. The ingestion of these produced a high quantity of methandienone metabolites in urine that would have resulted in a positive anti-doping test. One creatine product and three 'mental enhancers' contained traces of hormones or prohormones not claimed on labels, and fourteen prohormone products contained substances other than those indicated by the manufacturer. The oral intake of the creatine product revealed the presence of two main nandrolone metabolites in the urine (Baume et al., 2005).

This study highlights the risk of unintentional violation of the anti-doping regulations among athletes and those with an interest in fitness and training. The authors estimated one in five supplements on sale are contaminated with products that are not declared on the label (Baume et al., 2005).

## 3. Epidemiology

### 3.1. Patterns of use

AAS remain the primary way of enhancing appearance and remain the most popular of PIEDs. In medical applications of AAS (for example, low levels of serum testosterone), one type of AAS is administered continuously to maintain testosterone within the body's natural physiological range. This is not how AAS users self-administer for muscle shaping. Larger observational studies indicate that, typically, different combinations of AAS are 'stacked' and self-administered during 'cycles' lasting 4 to 12 weeks (sometimes longer). Regular users allow a 4-6 week rest period to 'clear the system', whereas less frequent users may be AAS-free for months (Evans, 2004; Peters et al, 1997).

In a study of 100 Australian AAS users (Peters et al., 1997), the average age of first use was 25 years, ranging from 14 to 46. There were a range of human and veterinarian, oral and injectable AAS used. There was an average of 2.5 different AAS preparations used in a cycle (only 30% of the sample used just a single type of AAS). The types of AAS used were predominantly veterinarian and injectable products.

Non-medical AAS users often start with lower doses, gradually increasing the dose each week (Evans, 2004; O'Sullivan et al., 2000; Peters et al., 1999). During the on-cycle, testosterone levels exceed the normal physiological range. The amounts taken for performance or image-enhancement are typically many times the therapeutic dose (Evans, 2004; Fudala et al., 2003; National Institute on Drug Abuse, 2000; Peters et al., 1997; Wu, 1997).

The intervals of use are usually determined by the amount of time the substance remains active in the body. For example, oral AAS are usually taken daily, oil-based injectable AAS are usually taken once or twice a week, and water-based injectable AAS are usually used every three days. Patterns of use vary from individual to individual and from cycle to cycle. The desired effects cannot be achieved by AAS use alone: a commitment to a strict diet and exercise regime is also necessary.

In addition to AAS, it is not uncommon to take a combination of other muscle-shaping drugs. Some of the substances used in conjunction with AAS cycles are used to manage the side-effects of supra-physiological levels of testosterone, such as anti-oestrogens and hCG (Bahrke & Yesalis, 2004; Evans, 2004; Fudala et al., 2003; Peters et al., 1997). A medical assessment of 51 male

AAS users in Sydney found that apart from AAS use, users reported taking growth hormone, thyroxine, human chorionic gonadotrophin (hCG), clenbuterol, diuretics, and tamoxifen (O'Sullivan et al., 2000).

There is a belief that different AAS interact to produce an effect on muscle size that is greater than the effect of each drug individually, or that some combinations of PIEDs are 'synergistic' (National Institute on Drug Abuse, 2000). These are theories that have not been tested scientifically. For example, there is a belief among some users that some AAS are better for 'cutting' (repartitioning, or defining muscle by burning off fat), where as others are better for 'bulking' (increasing muscle gains), and combining the two AAS gives the best effects. A further example is the belief in the synergistic effects of concurrent AAS and hGH use. Neither of these effects has been examined scientifically, yet they remain strongly held beliefs among PIEDs users.

### **3.2. Common forms and routes of administration**

The majority (76-86%) of AAS users self-administer injectable AAS (Bahrke & Yesalis, 2004; Evans, 2004; Peters et al., 1997). Oral testosterone is susceptible to rapid breakdown by the liver before it can act on the target organ or skeletal muscle. In order to increase the bioavailability of oral AAS, the 17 alpha-alkylated steroids were developed. The additional bond means the liver works harder to metabolise these steroids. However, the 17 alpha-alkylated steroids raise liver activity, which in turn increases the risk of liver damage.

There is an increase in the number of sublingual sprays, patches and percutaneous gels being marketed (for both AAS and other preparations), particularly via the internet (Bahrke and Yesalis 2004).

#### **3.2.1. AAS**

The main forms of AAS in Australia include intramuscular injection preparations (some veterinary products come in larger 'bladders') and oral tablets. More recently, oral paper products (AAS impressed in small paper squares for ingestion) have appeared in internet marketing. Other AAS preparations, such as gels, creams, skin patches and implants, are not widely currently marketed in Australia (although they are available).

### 3.2.2. Other PIEDs

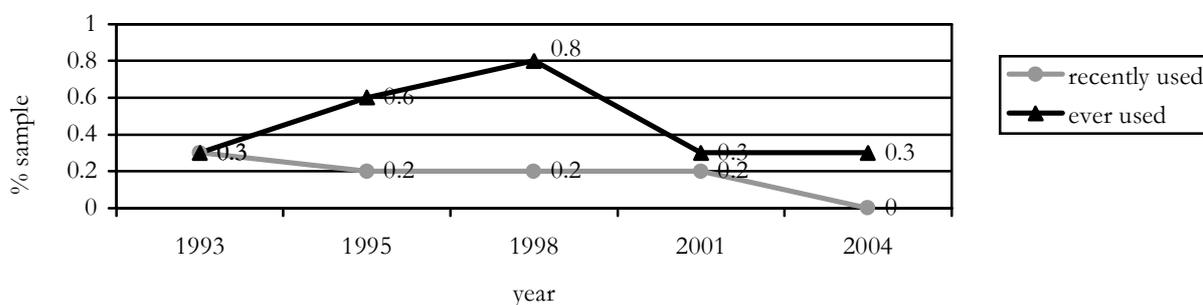
Androstenedione and DHEA are predominantly manufactured in the US, and marketed as ‘prohormones’. They are generally oral tablets, although there are also percutaneous gels and creams and sublingual/nasal delivery systems.

Clenbuterol is manufactured internationally in the form of oral tablets, gels or powders. Creatine monohydrate is usually an oral powder. EPO is usually an intravenous injection. hCG is usually a subcutaneous or intramuscular injection. hGH is usually a subcutaneous injection, but is sometimes administered intravenously. There are low concentration hGH oral tablets/sublingual preparations that are being marketed via the internet as ‘homeopathic supplements’. Like hGH, IGF-1 is an injectable preparation, but is most commonly being marketed as low concentration oral/sublingual ‘homeopathic supplements’. Insulin is usually injected subcutaneously and is sometimes taken as oral tablets.

### 3.3. Prevalence of use

The Australian National Drug Strategy (NDS) Household Survey gathers information regarding drug use from Australians (aged 14 years and over) every three years (n= 29,455 respondents in 2004). In general, the prevalence of AAS use among the NDS Household Survey sample has been low for both recent and lifetime use (consistently less than 1%).

**Figure 2: Proportion (%) of Australians aged 14 years and over who have ‘recently used’ steroids (in the last 12 months) and ‘ever used/ever tried’ steroids for non-medical purposes, 1993-2004**



SOURCE: Australian Institute of Health and Welfare (2005)

Results from the most recent National Drug Strategy Household Survey (2004) seem to indicate that while the number of Australians who have 'ever tried' AAS has stayed stable since 2001, the number of Australian who have 'recently used' AAS appears to have decreased significantly from 2001 (2-tailed  $\alpha=0.05$ : AIHW, 2005: p.3-4) (Australian Institute of Health and Welfare, 2005).

While the prevalence rates among the general population appear to be low, studies looking at particular subgroups have found higher prevalence rates of AAS use. For example, a 1994 survey of Australian weight-trainers and bodybuilders ( $n=197$ ) found that 16.2% of respondents (18.2% of males and 0.3% of females) had used AAS (Chee, Kuan, Rynn, & Teoh, 1994). Other international studies have examined a wider cross-section of gym-goers. Korkia & Stimson (1993) surveyed 1669 gym goers across 21 gyms in the UK. They found 7.7% (9% of men and 2% of women) reported having used AAS at some time, and 5% (6% of men and 1.4% of women) were current users (Korkia & Stimson, 1993). The prevalence of AAS among the 21 gyms studied ranged from no reports to 46% of respondents. Bolding et al (2002) found that among 772 gay men engaged in weight training in London gyms, 15.2% had ever used AAS (Bolding, Sherr, & Elford, 2002).

A study of NSP clients in northern areas of the UK saw a significant increase in new AAS users over 11 years of monitoring. While it was recognised that this finding might not accurately reflect any national trend, the data showed that 16.5% of transactions involved the provision of 100 or more syringes. It seems highly likely that at least some of these clients were obtaining injecting equipment for several users (McVeigh, Beynon, & Bellis, 2003).

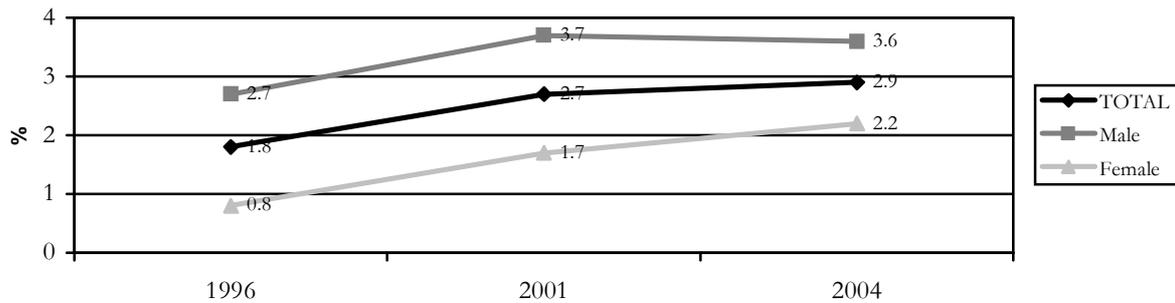
The largest body of prevalence data comes from international studies of secondary school students. Multiple US local, state and national level studies show that from 4% to 6% (a range of 3% to 12%) of high school males admit to non-medical use of AAS at some time in their life. Where these US studies also examined the use of AAS among females, it was found that from 1% to 2% of females reported having ever used AAS, with use by females having significantly increased over the past few years (Bahrke & Yesalis, 2004). Surveys conducted in Sweden, Norway, and England have generally reported lower rates of prevalence (see Table 4 below) - school-aged AAS use is between 1% and 4% in males and 0.2 and 2% in females (Bahrke & Yesalis, 2004; Yesalis & Bahrke, 2000).

| <b>Table 4: Self-reported prevalence of AAS use among high school students in international studies</b> |             |                |                    |                                 |                               |
|---|-------------|----------------|--------------------|---------------------------------|-------------------------------|
| <b>Author</b>   | <b>Year</b> | <b>Country</b> | <b>Sample size</b> | <b>Male (%)</b>                 | <b>Female (%)</b>             |
| Canadian Centre for Drug-free Sports#   | 1992-1993   | Canada         | 16,169             | 4.1<br>(used in last 12 mths)   | 1.5<br>(used in last 12 mths) |
| Lambert et al#  | 1998        | South Africa   | 1,136<br>1,411     | 1.2<br>4.4<br>(did not specify) | 0<br>0.1<br>(did not specify) |
| Handelsman & Gupta  | 1997        | Australia      | 13,355             | 3.2<br>(ever used)              | 1.2<br>(ever used)            |
| Wichstrom & Pedersen  | 2001        | Norway         | 8,508              | 1.2<br>(ever used)              | 0.6<br>(ever used)            |
| Kindlundh et al   | 2001        | Sweden         | 2,700              | 2.1<br>(ever used)              | 0.2<br>(ever used)            |
| Nilsson et al   | 2004        | Sweden         | 4,049              | 1.2<br>(ever used)              | Did not survey                |
| Miller et al  | 2002        | United Kingdom | 16,262             | 4.1<br>(ever used)              | 2<br>(ever used)              |

# as cited by Yesalis & Bahrke (2000: p.29)

The most recent national survey of Australian secondary school students in 2002 (n=23,417) found that 3.6% of males and 2.2% of females had ever used AAS ‘without a doctor’s prescription in an attempt to improve sporting ability, increase muscle size or improve appearance’ (see Figure 3 below) (White & Hayman, 2004). Among those males who had used recently, 36% had used these substances only once or twice, with a further 12% using them 3–5 times. Among females, 50% had only used them once or twice, with a further 22% using them 3–5 times. While the prevalence estimates were still low, the results did suggest that use was fairly regular among school students (White & Hayman, 2004). The rates of prevalence identified in school studies in Australia remain higher than those found in the National Drug Strategy Household Surveys.

**Figure 3: Proportion of Australian secondary students (aged 12-17 years) who had ‘ever used’ steroids without a doctor’s prescription in an attempt to improve sporting ability, increase muscle size or improve appearance, 1996-2001**



Source: (Letcher & White, 1999; White, 2001; White & Hayman, 2004)

It is extremely difficult to ascertain the exact number of people in Australia using AAS or other PIEDs for non-medical purposes. Most of the prevalence data available in Australia focuses on the use of AAS, and there are limitations. For example, by assuming rates of PIEDs use will be even across all geographic areas surveyed in the NDS Household Survey, this survey might be under-estimating AAS use. It is possible that there are higher rates of AAS use in some geographic locations than in others. The available data on non-medical use of AAS does not separate sporting use from other types of non-medical use (e.g. body image use) and no prevalence data is available on the illicit use of other PIEDs (such as hGH, DHEA, hCG, clenbuterol, etc).

## 4. Populations of PIEDs users

The use of PIEDs in Australia is not just within the sporting community, but extends to the non-sporting sectors of Australian life (Australian Olympic Committee, 2000). Although there are groups who are legitimately prescribed substances such as AAS for medical reasons, there are others who use PIEDS for non-medical purposes.

The motivations for the non-medical use of substances like AAS are inherently personal to the individual (Peters et al., 1999). However, non-medical PIEDs users have generally been thought to fall into four categories (Australian Olympic Committee, 2000; Bolding et al., 2002; Peters et al., 1999; Peters et al., 1997; Shapiro, 1994), listed below:

- Elite athletes
- Body image users
- Occupational users
- Adolescents

In a study of Australian AAS users (n=100), subjects were asked to identify what type of user they would classify themselves as. Over one third (39%) described themselves primarily as 'bodybuilders', and 28% described themselves as 'body image' users. A further 12% classified themselves as both 'bodybuilders' and 'body image' users, being unable to distinguish between the two. 'Competitive athletes' and 'weight-training' users each made up only 6% of the sample. Only one of the sample identified themselves as an 'occupational' user, although 5% described themselves as 'occupational' and 'body image' users. The remainder preferred to describe themselves as 'life enhancing' users (3%) (Peters et al., 1997).

### 4.1 Elite athletes

Non-medical use of PIEDs has gained widespread attention because of its use by elite athletes. Doping in sports is not a new phenomenon. The first reports of doping in sports reportedly date back to the ancient Olympic Games in the third century B.C., and at the turn of the century strychnine, cocaine, heroin and ethyl alcohol were commonly used (Haugan, 2004; Kennedy, 2000).

Today, sports-users are using more advanced methods, typically involving the use of substances that mimic natural processes in the body such as testosterone, growth hormone, EPO, and substances mimicking the action of adrenalin (Magkos & Kavouras, 2004; Sonksen, 2001; Tokish et al., 2004).

In response to the increasing range and sophistication of performance-enhancing substances used by athletes, the World Anti-Doping Agency (WADA) was created in November 1999 with a 2004 budget of US\$21.5 million. It funds mostly research into keeping abreast of the development of performance-enhancing substances.

In Australia, the Australian Sports Drug Agency (ASDA) was established following the introduction of the *Australian Sports Drug Agency Act 1990* to deal with the problem of drug use in sport. ASDA's mission was to deter the use of banned doping practices in sport through education, testing, advocacy services and co-ordination of Australia's anti-doping program. ASDA's programs are directed at athletes, coaches, sports science and medical personnel and sports administrators. In 2005, a new independent body was set up, called the Australian Sports Anti-Doping Authority (ASADA). ASADA incorporates the established functions of ASDA and adds new functions including the investigation of doping allegations and presentation of cases at hearings.

Athletes who use performance-enhancing substances are motivated by a desire to win, and by the subsequent rewards, financial and otherwise. Described as 'win at all costs', this resolution is reinforced by a belief that their competitors are also using (Yesalis & Bahrke, 2000). Our social fixation on winning has led to a demand for PIEDs in sports (Yesalis & Bahrke, 2000). Although this group receives the highest media profile due to our sports-celebrity culture, it is now believed that athletes make up just one small group of PIEDs users. To date, the literature on PIEDs has focused largely on drugs in sport (e.g. Bahrke & Yesalis, 2002; Bahrke & Yesalis, 2004; Chyka, 2003; Corrigan, 1999; Delbeke, Van Eenoo, Van Thuyne, & Desmet, 2003; Dunning & Waddington, 2003; Kennedy, 2000; Kennedy & Kennedy, 1999; Kennedy & O'Sullivan, 1997; Kicman & Gower, 2003; Magkos & Kavouras, 2004; Mendes et al., 2004; Sonksen, 2001; Tokish et al., 2004; Volek et al., 2004). To redress the balance, this review focuses predominantly on the non-medical use of PIEDs by groups other than elite athletes.

## 4.2 Body image users

### 4.2.1 Research on men and body image

The literature concerning men and body image seems to support the view that body image distortions in men do exist. However, the issue of body image concerns for men continues to receive less attention in the scientific literature than body image concerns among women. Throughout the past decade, however, issues surrounding men's bodies and body image have been gaining increased attention in terms of academic scrutiny as well in popular media (Cafri & Thompson, 2004; Drummond, 1994; Edwards & Launder, 2000; McCabe & Ricciardelli, 2004; Olivardia, Pope, Borowiecki III, & Cohane, 2004; H. G. J. Pope et al., 2000; Wroblewska, 1997).

Recent research has been examining the 'ideal' male body and male dissatisfaction with body image. A study by Pope and colleagues (2000) conducted in Austria, France and the US measured body image perception among men. They found that in all three countries, men chose an ideal body that was a mean of 13kg more muscular than their own body, and estimated that women preferred a body that was 14kg more muscular. Interestingly, women (in a separate pilot) were found to prefer the typical male body, without the additional muscle.

In a US study, Olivardia and colleagues (2004) found marked differences between American men's ratings of ideal and actual bodies. The men chose an ideal body with a mean of about 25 pounds (11kg) more muscle than their actual level of muscularity. They also chose an ideal body that was about 8 pounds (3.5kg) less fat than their actual levels of fat. This study also found that men thought women would select an ideal male body that was more muscular than the women's actual ideal. The authors suggested that their results showed that the bodies men were rating as 'ideal' were selected partly to express their desire to gain respect from other men, as well as to be attractive to women. Muscle belittlement, but not fat exaggeration, was positively correlated with depression (i.e. muscularity is more consequential than fat). The authors concluded that contemporary American men display substantial body dissatisfaction and that this dissatisfaction is closely associated with depression, measures of eating pathology, use of performance-enhancing substances and low self-esteem.

Physique and physical appearance are ever-important in how people are viewed in their social environment. A good physique and physical appearance has benefits: social acceptance, admiration and opportunity (Schwerin et al., 1996). The pressure to 'look good' appears to be both internal and external. The findings of past research have been mixed with regards to levels

of body dissatisfaction in men and the extent to which they differ from women. In women (and some men), this pressure has generally been considered to contribute to the development of eating disorders, and there is a large body of research focusing on the desire for thinness. In men, and to some extent in women, the desire may be to be more muscular.

It has been suggested that there has been a state of change in cultural attitudes towards men's bodies since the 1980s. Cultural norms and ideals regarding the male and female body have changed, as have fashions, over the years. The 'ideal' male body is the familiar image of a well-defined, muscular man with large arms and upper chest, a '6-pack' abdomen and slim hips (the classic V-shape) (Grogan & Richards, 2002; Leit, Gray, Harrison, & Pope, 2002; Leit, Harrison, Pope, & Gray, 2001; Schwerin et al., 1996; Wroblewska, 1997). Media images of men have changed over the last 20 years, just as they have for women. While women pictured as 'desirable' in magazines such as *Playboy* have become slimmer over time, men pictured in similar magazines have been getting bigger. Described as 'commodification' of the male physique by Pope and colleagues (2000), this area of research has gained increasing attention.

Leit and colleagues (2001) examined the male centrefold models in *Playgirl* from 1973 to 1997. They used two measures of body mass – the Body Mass Index (BMI) and the Fat Free Mass Index (FFMI). The BMI is the traditional way of measuring body mass (and hence, body fat), and can be calculated using the following formula:

$$\text{BMI} = W / (H^2)$$

(where  $W$  = weight in kilograms; and  $H$  = height in metres)

However, this method has its limitations. For example, it may overestimate body fat in athletes and others who have a muscular build, or underestimate body fat in older persons and others who have lost muscle mass. Accordingly, Leit and colleagues (2001) use a measure of lean body mass, the FFMI, using a further estimate of % body fat (usually based on waist, abdomen, hip and wrist measurements).

$$\text{FFMI} = W \times ((1 - \text{BF}) / 100) / H^2 + 6.1 \times (1.8 - H)$$

(where  $W$  = weight in kilograms;  $\text{BF}$  = estimated % body fat; and  $H$  = height in metres)

The FFMI provides a more direct estimate of muscularity because it eliminates body fat by calculating the lean BMI and then adding a small correction for height (based on the average

height of 1.8 meters). The average fat-free mass index (FFMI) of a male who does not lift weights is around 15-20. Weightlifters who do not use AAS typically have a FFMI of around 21-25. A FFMI in the high 20s is likely to indicate AAS use (Olivardia et al., 2004). Leit and colleagues (2001) found that the male *Playgirl* models became increasingly 'dense' (based on measures of a higher BMI and a higher FFMI) over time (by year of publication).

Leit and colleagues (2002) proposed that the trends in male body image may contribute to psychopathology, citing studies by Blouin and Goldfield (1995); Pope, Gruber, Choi, Olivardia and Phillips (1997); and Leit (1998), that link the cultural ideals of muscularity with lower self-esteem about appearance and possible abuse of AAS.

In their 2002 study, Leit and colleagues demonstrated a link between cultural ideals of muscularity and self-esteem among men. They showed one group of college men advertisements featuring muscular men and the control group were shown neutral advertisements. Immediately after, the two groups completed a computerised test of body image. The students exposed to the muscular images showed a significantly greater discrepancy between their own perceived muscularity and the level of muscularity they ideally wanted. The authors concluded that the media could influence men's satisfaction with their musculature. This dissatisfaction was primarily with respect to musculature, rather than body fat, a finding consistent with previous evidence that muscularity is more important than body fat in men's body satisfaction (Leit et al, 2002).

The rise in the gym culture for men may also be evidence of shifting cultural norms regarding men's bodies (Grogan & Richards, 2002; Labre, 2002; Wroblewska, 1997). This interest in a larger, or 'mesomorphic', figure seems to be reflected in the increasing popularity of working out with weights. In a study of fitness leaders in Australia, Philips & Drummond (2001) concluded that they were highly conscious of physical appearance and exhibited a preoccupation with low body fat levels, for themselves and for others. The authors concluded that these beliefs could, in turn, have negative effects on clients who may have weight and body image concerns (Phillips & Drummond, 2001).

Labre (2002) cites US media reports showing the increasing popularity of weight training machines, gym memberships and performance enhancing nutrition supplements. From 1994 to 1998, sales of strength training machines in the US increased from \$115 million to \$125 million. Health club memberships grew from 13.8 million in 1987 to 22.4 million in 1997. In addition,

the retail of sports supplements such as creatine also increased dramatically. In one year alone, from 1999 to 2000, they increased 6%, from \$525 million to \$555 million and were projected to reach \$656 million by 2005.

According to an article in *The Sydney Morning Herald* (5 February 2005), gym memberships are following the same trends here. According to the industry body, FitnessNSW, there are 450 clubs in NSW and 1200 across Australia, catering to more than 500,000 members.

At a time when the prevalence of obesity in Australia has more than doubled in the past 20 years (Cameron et al., 2003), the promotion of a muscular male body ideal may be viewed as having the positive effect of promoting physical exercise. However, the hyper-male ideal in the media is an extreme goal. For most men, this ideal is neither achievable nor required for optimum health (Harvey & Robinson, 2003; Peixoto Labre, 2002).

Many studies have concluded that men may pursue unhealthy activities in order to achieve an unrealistic ideal. This could result in body (or muscle) dissatisfaction, anxiety, eating disorders, muscle dysmorphia, and misuse of AAS and use of untested dietary supplements (Cafri & Thompson, 2004; Drummond, 2005; Harvey & Robinson, 2003; Leit et al., 2002; Olivardia et al., 2004; Olivardia, Pope, & Hudson, 2000; Peixoto Labre, 2002; H. G. J. Pope et al., 2000; Schwerin et al., 1996; Wroblewska, 1997). It could be argued that the physical changes and the accompanying psychological effects of increased confidence, self-esteem, social benefits and elevation in mood may be the key factors in supporting and continuing AAS use in men with distorted body images (Peixoto Labre, 2002).

#### **4.2.2 Reverse anorexia**

Just as eating disordered women look in the mirror and see themselves as bigger than they are, some men look in the mirror and see themselves as smaller than they are (Schwerin et al., 1996). 'Reverse anorexia' was the term used to describe the chronic distorted perception of being too small and/or insufficiently muscular (H. G. J. Pope et al., 2000). Drawing on comparisons with anorexia, the assumption is made that both groups take the cultural standard of bodily perfection to the extreme, and both use unhealthy behaviours such as severe food restriction, excessive exercise and drugs (such as AAS) in pursuit of their goal. Reverse anorexia is reportedly most prevalent among bodybuilders, but is also found in other male gym users (Pope et al., 2000).

Examining the concept of reverse anorexia in men, Davis & Scott-Robinson (2000) compared the psychological profiles of women with anorexia nervosa and competitive male bodybuilders. They found that the psychological profiles of bodybuilders are very similar to those found in women with anorexia nervosa. Both groups were significantly more obsessional, perfectionistic, anhedonic (the ‘diminished ability to experience pleasure, independent of the ability to experience pain’) and pathologically narcissistic than the general population (Davis & Scott-Robinson, 2000).

Cole et al (2003) compared samples of regular aerobic exercisers, bodybuilders who were currently using AAS, bodybuilders who were ex-users of AAS and bodybuilders who had never used AAS. They used a modified version of the Eating Disorder Inventory (EDI) and administered the Severity of Dependence Scale (SDS) for both exercise and AAS use. They found that current and ex-AAS using bodybuilders had higher scores on all sections of the EDI than both groups of non-AAS users. AAS use, but not bodybuilding per se, was associated with increased symptoms of ‘reverse anorexia’, and this symptomatology was higher in those who had higher scores on the SDS for AAS use (Cole, Smith, Halford, & Wagstaff, 2003).

Peters and Phelps (2001) found that body dissatisfaction was present for both male and female bodybuilders, concluding that weightlifting did not generate contentment with one’s body. Instead, bodybuilders set higher and higher goals – just like eating disordered females who strive endlessly for unrealistic emaciated perfection. These authors suggested that bodybuilders may suffer from a ‘muscular ideal’ similar to that of a ‘thin ideal’ (Peters & Phelps, 2001).

However, while commonalities have been found between the two groups, two studies have found that bodybuilders reported positive self-worth, unlike anorexia patients who show very negative self-perceptions (Davis and Scott-Robinson, 2000; Schwerin et al., 1996). It appears that while bodybuilders may strive for an unrealistic muscular ideal, this may not always translate to low body esteem.

#### **4.2.3 Body Dysmorphic Disorder/Muscle Dysmorphia**

In 2000, Olivardia and colleagues proposed to change the name of the ‘reverse anorexia’ syndrome to ‘muscle dysmorphia’. They define ‘muscle dysmorphia’ as a form of Body Dysmorphic Disorder in which individuals develop a pathological preoccupation with their muscularity. Body Dysmorphic Disorder (BDD) is described by the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV; American Psychiatric Association,

1994) as a preoccupation with some defect in appearance or over-exaggeration of a slight physical anomaly. The preoccupation is time-consuming and causes significant distress or impairment in social, occupational, or other important areas of functioning.

BDD is believed to be an OCD-spectrum disorder, and is distinct from eating disorders. BDD often goes unrecognized and undiagnosed, due to the reluctance of those affected to divulge their symptoms because of secrecy and shame. Any body part can be the focus of concern (most often the skin, hair, and nose), and most patients engage in compulsive behaviours, such as mirror checking, camouflaging, excessive grooming, and skin picking (Cororve & Gleaves, 2001; Sobanski & Schmidt, 2000).

In Olivardia and colleagues' (2000) description of muscle dysmorphia, men may believe themselves to be of very small musculature, even when they are highly muscular. They tend to exercise obsessively (particularly weight training), are at risk of AAS misuse, tend to avoid situations and places where they might be seen without clothing (or it causes them distress), and often wear many layers of clothing. Social relations and occupational functioning can be adversely affected as a result (Choi, Pope, & Olivardia, 2002).

Men with muscle dysmorphia are thought to be more likely to be less happy with their bodies, have disordered eating attitudes, an increased prevalence of AAS use, a strong desire for greater musculature and are very concerned not to gain any fat (Olivardia et al 2000; Choi, Pope et al 2002). Men with muscle dysmorphia may exercise compulsively by lifting weights, and often show a discrepancy between what the mirror shows and what they see. The behaviour of these men is believed to be obsessive-compulsive and leads to strained relationships, impaired social activities and occupational dysfunction.

However, there is disagreement with the proposed criteria and classification of muscle dysmorphia as a form of BDD. For example, classification of muscle dysmorphia as a form of BDD assumes the preoccupation with one's body build is 'abnormal'. On the other hand, consideration of muscle dysmorphia as an obsessive-compulsive disorder focuses attention on the extreme and repeated behaviour (Chung, 2001). However, even in this context, making judgements of what constitutes 'extreme' behaviour also poses challenges. For example, the behaviour of an elite athlete (such as training intensely for hours a day, being concerned with weight, managing their diet and sacrificing important social events to maintain workout schedules) may meet the diagnostic criteria for muscle dysmorphia; however, their behaviour is

sanctioned by their athletic culture. Chung (2001) asks: 'is it possible to differentiate between a healthy enthusiasm and muscle dysmorphia?'.

#### **4.2.4 Weight trainers and bodybuilders**

The groups most commonly assumed to have higher rates of AAS use, and which frequently feature in the literature, are bodybuilders and weight-trainers. While bodybuilding and powerlifting are competition sports, there are recreational bodybuilders and weight-trainers who are motivated by improving their physical appearance (e.g. Bahrke & Yesalis, 2004; Peters et al., 1997). Bodybuilding is based on taking musculature to the extreme. Bodybuilders are known to use a range of PIEDs to complement their weight-training, most commonly anabolic substances like AAS and growth hormone. However, in preparing for competition, competitive bodybuilders will use a range of substances to enhance muscle definition, such as 'fat burners' such as stimulants (ephedrine, amphetamine) or beta-agonists (such as clenbuterol).

Many studies of bodybuilders have focused on the issues of body image and body dissatisfaction. These studies do not present a conclusive picture. Some have found that AAS-using bodybuilders have a poor body image (e.g. Peters & Phelps, 2001) while others have found this group to have high body esteem, at least for the upper body (e.g. Schwerin et al., 1996; Davis & Scott-Robinson, 2000). One study found that AAS-using bodybuilders were less confident than non-users about their body appearance at the time they started lifting weights (Kanayama, Harrison, Pope, Cohane, & Hudson, 2003). An explanation of the mixed findings may be that the physical outcomes of AAS use in combination with weight-training (increasing muscle size) may enhance body image over time. It has been suggested that when the physical outcomes of AAS use are no longer present, positive body image may also disappear (Schwerin et al., 1996).

Other studies have examined the characteristics of bodybuilders and potential correlates of AAS use. Both AAS users and non-users reported similar childhood experiences and family backgrounds, but users reported significantly poorer relationships with their fathers and greater childhood conduct disorder than non-users (Kanayama et al., 2003). AAS users displayed higher rates of other illicit drug use, with use of other substances almost always preceding AAS use (Kanayama et al., 2003). The authors suggest that AAS use may be most likely to occur in men with high levels of antisocial traits and low levels of body esteem.

Studies have documented bodybuilders' attitudes and motivations relating to AAS use and health. The most commonly reported motivations for AAS use are to excel in competitive bodybuilding;

wanting to be more muscular; and feelings of enhanced confidence (Peters et al., 1997; Wright, Grogan, & Hunter, 2000). To the outsider, it seems contradictory that those who otherwise engage in 'healthy' exercise regimes would use illicit AAS. AAS using bodybuilders are less likely to be concerned about the physical side effects and many believe that AAS are not harmful in moderation, and that only 'ignorant people' criticise their AAS use (Monaghan, 2002c; Wright et al., 2000).

AAS use among bodybuilders is often rationalised as a legitimate means to an end, and any observers passing negative comments are rejected. Users believe that AAS do not harm the user's health or harm society (Monaghan, 2002). Medicine and bodybuilding have an awkward relationship. For many years, the predominant medical view was that there was no evidence of the effectiveness of AAS, and that the harms of AAS were extreme – this view undermined the medical profession in the eyes of bodybuilders. Bodybuilders systematically disavowed medical pronouncements on the (lack of) effectiveness and risks of 'physique-enhancing' drugs, leaving medicine in an ambiguous role as a source of knowledge and expertise (Monaghan, 1999). One study demonstrated that AAS-using bodybuilders rate their physician's AAS knowledge as no more reliable than friends, internet, or dealers. Among users, 43% trusted information from their drug dealer at least as much as their physician, and 56% had never revealed their AAS use to their physician (Pope, Kanayama, Ionescu-Pioggia, & Hudson, 2004).

In our society, individuals are labelled as 'disordered' if they have a strong drive for thinness and engage in extreme dieting. On the other hand, a strong drive for muscularity is typically valued and admired (Davis & Scott-Robinson, 2000). It has been suggested that since the mesomorphic form conveys an appearance of great strength and physical fitness, both the bodybuilder and the general public may risk under-appreciating the seriousness of the practices such as AAS use and excessive dieting that are necessary to achieve this physique (Schwerin et al., 1996).

#### **4.2.5 Gay men**

Gay men have been identified as a particular subgroup at risk of body dissatisfaction. There is evidence that gay men may be more susceptible to body image concerns, including eating disorders and AAS use, than heterosexual men. This is believed to be due to the emphasis on physical attractiveness within some sections of their culture (Conner, Johnson, & Grogan, 2004; Drummond, 2005; Harvey & Robinson, 2003; Siever, 1994; Yelland & Tiggemann, 2003).

Similarities have been drawn between gay men and heterosexual women with respect to the pressure to 'look good' to partners. There is a shared emphasis on physical attractiveness and thinness that is based on a desire to attract and please men (Conner et al., 2004; Siever, 1994). Gay men, like women, can experience extreme pressure to be eternally fit and youthful looking. For gay men, this pressure to be thin, however, has evolved to mean the pressure of being devoid of fat (Drummond, 2005). The 'ideal' body involves having low body fat and being lean, but also being highly muscular (Drummond, 2005; Harvey & Robinson, 2003; Siever, 1994; Yelland & Tiggemann, 2003).

In detailed interviews with a group of young Australian gay men, Drummond (2005) documented that the group felt a pervading expectation being placed on them as a consequence of the media and advertising. These images were also beginning to have a negative effect on their body image. They felt pressured to look like the images, and to 'pick up' partners who matched these images.

Given the research that body image disturbance in males may precipitate AAS use, and that gay men may exhibit greater body dissatisfaction, it is surprising that there is so little research looking at the relationship between body dissatisfaction and subsequent use of AAS among gay/bisexual men.

Dillon et al (1999) found that among their predominantly male sample (94%) of 100 AAS users in Sydney, Australia, 27% were gay/bisexual men. The gay/bisexual men who used AAS reported different patterns of AAS use – they started using at a later age, used smaller quantities less frequently and were also more likely to have used a wide range of illicit drugs. The gay/bisexual men were more likely to identify as 'body image' users and to indicate that their motivation to use on their first and most recent occasion was to improve appearance, despite there being no differences in the way in which heterosexual and gay/bisexual men perceived their body shape (Dillon, Copeland, & Peter, 1999).

Out of 772 gay men surveyed in London gyms, 1 in 7 said they had used AAS in the last twelve months (Bolding et al., 2002). HIV positive men were more likely to have used AAS than other gay men, some for medical reasons, but some to look healthy. After taking therapeutic use into account, the prevalence of recreational AAS use among this group was higher than other male gym-goers in the UK. Bolding et al's (2002) study also confirmed Dillon et al's (1999) findings that gay men were most commonly motivated to use AAS to improve their appearance. They were also more likely to use a wide range of illicit drugs.

Other studies have shown that in HIV-positive gay men, the HIV-related weight loss causes significant emotional problems. HIV-related weight loss may affect social confidence and functioning, undermine bodily effectiveness and comfort, and be perceived as a sign of progressing illness (Tate & George, 2001). As one commentator described:

‘The perfected gym body has become a universally recognised icon in contemporary gay male society, and the internalisation of this body image has had a widespread impact on the way in which many gay men feel about themselves...’  
‘...In addition to the medical reasons for keeping fit, a pumped up body has also become a symbol of health... For the ever-growing numbers of long-term HIV-positive survivors, the ability to do strenuous aerobic exercise, lift weights and bulk up is a potent and visceral way of reminding people that they’re not ill.’  
(Shernoff, 2001: p.32-33).

HIV positive men are more likely to have used AAS than HIV negative or never tested men. The reasons given are both medical (to combat muscle wastage or weight loss) and to look healthy (Bolding et al., 2002; Bolding et al., 1999). Gay men with HIV infection face an elevated risk of suicide and suicidal ideation, both of which are also associated with AAS use. Consequently, the use of AAS by HIV positive gay men may further increase this risk (Bolding et al., 1999).

It needs to be noted that not all studies found body dissatisfaction among gay men. In fact a study by Hausmann et al (2005) found that there were no differences between gay men and heterosexual men on multiple measures of body image. The authors have suggested that other findings may be due to selection bias (i.e. perhaps gay men are more likely to seeking help or treatment for eating disorders than heterosexual men, or are more open about their body image issues and more willing to participate in health research) (Hausmann, Mangweth, Walch, Rupp, & Pope, 2005).

### **4.3 Occupational users**

For some, the use of AAS serves a direct purpose, usually in the carrying out of employment duties (Shapiro, 1994). The functional user believes that their ‘survival’ depends on their physical ability. The example provided by Dart (1991) (cited by Peters et al., 1997) is a policeman who, as their concern for their ability to protect themselves increases, the incidence of AAS use might

increase, giving them the ‘physical edge they fear they lack’. The kinds of professions that may be at risk of functional misuse of AAS and related substances include: police, door staff/security personnel, bodyguards, fire fighters, members of the armed forces and members of street gangs (Australian Olympic Committee, 2000; Maycock, 1999; Monaghan, 2002a, 2002b; Mugford, 1995; Peters et al., 1997).

The ways in which AAS might give a ‘physical edge’ are two-fold. The first is through achieving an enhanced physique. The second is through enhanced aggression levels. Thiblin (1999) observed that certain criminals may use AAS in advance to planned violent activity, in order to benefit from the heightened arousal to anger and aggression, and central stimulatory effects. It follows that the functional use of ‘increased arousal’ may be attractive to professions where there is a need to react quickly and confidently (Thiblin, 1999).

#### **4.3.1 Men working in the security industry**

A submission by the Australian Olympic Committee to the Standing Committee on Family and Community Affairs (2000) cites the concerns raised by the Senate Standing Committee on the Environment, Recreation and the Arts, which enquired into ‘Drugs in Sport’ (the ‘Black Committee’) in 1990, regarding the tendency for a very high percentage of bouncers to be AAS takers. The report indicates concern regarding the high doses of AAS consumed, aggression in nightclubs and hotels, and the criminal records of many bouncers.

The security industry enjoyed a period of intensive growth in Australia throughout the 1970s and 1980s. ‘Private’ or ‘contract’ security makes up the larger part of the industry (Prenzler & Sarre, 1998). In Australia, security services play a central role in crime prevention and law enforcement and there are approximately twice as many licensed security providers than there are police (Prenzler & Sarre, 1998). The large, but often hidden, presence of security providers raises some questions about the implications of the growth of social control by ‘non-police’ agencies. It follows that a growing amount of crime and anti-social conduct is being dealt with privately, rather than through the criminal justice system. The rapid growth of the security industry has resulted in problems in some Australian states, where security services have been implicated in harassment, violence and criminal involvement (Prenzler & Sarre, 1998).

These public safety concerns are further compounded by suspected AAS use among this group. However, this is a group that is not frequently identified in the scientific literature. To date, studies have not examined the prevalence of use among this group, or the size of the problem.

Our current knowledge is based on studies of the night-time economy and qualitative interviews with individuals who are known to use AAS.

The relationships between pubs, doorstaff and violence are difficult to determine. Quigley et al (2003) found that the distinguishing characteristics of violent bars were the presence of bouncers and male staff. Bouncers were thought to be a reaction to violence in some cases, and causes of violence in others (Quigley, Leonard, & Collins, 2003).

Other qualitative studies of Britain's night-time economy have explored the themes of masculinity and violence (Monaghan, 2002a, 2002b). These studies focus on bouncers and their emphasis on their 'bodily capital' (i.e. their body build and acquired body techniques). For this group, physicality is central to the practicalities of doorwork and risk management. The physical body is the economic asset, and the means by which bouncers get the job done. Working on the door is described as a 'masculinist occupation that values strong working bodies'. Monaghan (2002) described how economic drivers also contribute to this culture. For example, in order to minimise security costs, managers will opt out of having large door teams in favour of having large doormen.

Although AAS are not necessarily causally linked to uncontrollable aggressive violence, synthetic testosterone has been shown to exert a negative effect upon mood and behaviour. If doorstaff abuse AAS, then the bodily risk (for the workers and their charges) may increase (Monaghan, 2003).

Maycock (1999) conducted studies of Australian AAS users who had experienced violent episodes. Those who were most violent were employed or had been employed as doormen. There was a view among this group that recreational bodybuilders' size had 'no functional use', while they on the other hand could 'handle themselves'. This group gave the need for respect and the need to protect themselves as reasons for starting AAS use and weight-training (Maycock, 1999: p.9).

In this review of the link between AAS use and violence, Maycock (1999) discusses the socialisation of doormen and highlights that there are significant reductions in the social sanctions restricting violence in this setting. In fact, being tough and becoming violent if the situation demanded it, are ways of being known as competent. Many believed their violent

episodes were contributed to by AAS use. However, this group also identified that aggression was linked to amphetamine use, sleep deprivation and alcohol use (Maycock, 1999).

Although occupational or functional use of AAS has been demonstrated (Maycock & Beel, 1997; Mugford, 1995; Peters et al., 1997; Shapiro, 1994; Thiblin, 1999), it is premature to conclude that one occupational group is most 'at risk'. While purposive sampling is a valid method of recruitment, the focus on men working in the security industry may be a selection bias. There are, for example, other occupational groups such as construction workers and personnel from armed forces and law enforcement for which functional use of AAS may also have perceived benefits.

## **4.4 Adolescents**

### **4.4.1 Adolescent males and body image**

The group that are most often identified in the literature as being at risk of body image concerns are adolescents. Adolescence is the age for the development and maintenance of physical health care behaviours, self-esteem, self-identity and psychological wellbeing (Wroblewska, 1997). Adolescent identity is closely linked to the image that is portrayed, and the lure of 'looking good' is powerful at any age. Young men may be more susceptible to the social pressure to achieve the same physique as adult men portrayed in the popular media (Australian Olympic Committee, 2000; Drummond, 2005; McCabe & Ricciardelli, 2004; Peters et al., 1999; Thomson, 1999).

The Western 'ideal' of the male body is a physique that is highly muscular, athletic and devoid of fat (Drummond, 2005). AAS are seen as a quick and effective way of escaping the limitations of an adolescent body and progressing to adulthood. Given that the use of AAS can initiate premature secondary sexual characteristics and increased sex drive, Thompson (1999) argues that it is easy to understand the attraction for young men.

Like research with adult men, research with adolescent boys has found mixed results regarding the levels of body dissatisfaction. It is a common finding that adolescent females have more body dissatisfaction than adolescent males. However, studies often make the assumption that it is the desire to be smaller and lose weight that indicates dissatisfaction. Body image studies do not always adequately capture adolescent boys' desire to be bigger and more muscular (McCabe & Ricciardelli, 2004).

McCabe and Ricciardelli (2004) cautiously interpret body image research as demonstrating that pre-adolescent boys seem primarily satisfied with their bodies. However, as boys move closer to adolescence, they also appear to be more attuned to the sociocultural ideal for a male body (mesomorphic, V-shaped body with broad shoulders and a slim waist). It has been estimated that 50-70% of Australian adolescent boys reported a desire to change their body shape or weight in some way (Humphreys & Paxton, 2004; Ricciardelli, McCabe, & Banfield, 2000).

International studies of adolescent boys confirm that they do experience body dissatisfaction and some degree of social pressure to look good. Grogan and Richards (2002) found that UK boys and young men linked being lean and muscular with being healthy and fit. Sixteen year olds in particular described peer pressure to be lean and muscular, and adult men and teenagers explicitly linked having a well-toned muscular body with feelings of confidence and power in social situations (Grogan & Richards, 2002). Among a Swedish sample of 14, 16 and 18 year olds, Nilsson et al (2004) found that the desire for large muscles in order to improve one's appearance was the main reason reported for using AAS (Nilsson, Spak, Marklund, Biagi, & Allebeck, 2004).

Australian studies have examined the influence of idealised media images and social relationships on adolescent body image. While, on average, 16 year old boys did not show more negative body image or mood following exposure to idealised male figures, individual differences were found. Most notably, those boys who had prior body dissatisfaction and internalisation of the muscular male ideal did show negative responses to viewing idealised images (Humphreys & Paxton, 2004). In a separate study, Ricciardelli et al (2000) found that for at least a third of boys aged 12-15 years, parents, siblings, friends and the media exerted some influence over the way they felt about, and made changes to, their bodies. Female influences (mothers and female friends) were found to have a positive influence on body image, whereas male influences (fathers and male friends) were viewed as important in influencing body change methods. It appears that there are some boys who are more susceptible to external influences on their body image.

International studies suggest that adolescents are using a range of drugs to enhance their appearance. These drugs include, among others, caffeine, amphetamines, human growth hormone, clenbuterol, androstenedione, DHEA, GHB, AAS, creatine and other untested 'dietary supplements'. Until recently, 'prohormones' such as DHEA and androstenedione were available to adolescents as over-the-counter 'dietary supplements' in the US (Peixoto Labre, 2002; Yesalis

& Bahrke, 2000). Recent legislative changes are expected to restrict the supply of these substances.

While this discussion has focused mainly on adolescent males, there are a small number of adolescent women who desire to be bigger and weigh more than they do. Although the prevalence rates of AAS use among female adolescents remains lower than the rates for males, use among adolescent females in the US has been gradually increasing since 1991 (Yesalis & Bahrke, 2000). This is concerning considering the risk of irreversible effects of AAS use on females. The impact on adolescent females in particular is unknown. For adolescent males, AAS use is associated with a desire for a leaner, more defined body; for females, AAS use is associated with a desire to be bigger (Irving, Wall, Neumark-Sztainer, & Story, 2002).

#### **4.4.2 Correlates of PIEDs use among adolescents**

There is a range of characteristics and correlates associated with AAS use among adolescent males and females. Studies have linked AAS use to involvement in power sports, 'demographic characteristics' (such as gender, ethnicity, income, etc), 'risk-taking' and problem behaviours, and a range of other social, personality and health characteristics.

The characteristics most commonly associated with AAS use among adolescents include ethnicity, gender and involvement in power sports (Irving et al., 2002; Kindlundh, Hagekull, & Isacson, 2001; Wichstrom & Pedersen, 2001). Links between ethnicity and AAS use have been identified in a number of international studies (Handelsman & Gupta, 1997; Irving et al., 2002; Kindlundh et al., 2001; Nilsson et al., 2004). An Australian study found that Aboriginal and overseas born adolescents were more likely to have ever used AAS (Handelsman & Gupta, 1997). This study also found that being male, having a higher student income and a lower level of social support were associated with lifetime use of AAS (Handelsman & Gupta, 1997). However, involvement in power sports and demographics is only part of the picture. As Miller and colleagues (2002) point out, despite the stereotypical imagery of the male athlete user, both non-athlete and female users also face elevated risks of other forms of 'risk-taking' and problem behaviours (Miller, Barnes, Sabo, Melnick, & Farrell, 2002).

Adolescent AAS use has been linked with a range of risk-taking and problem behaviours. Truancy, aggression, sexual risk taking, and vehicular risk taking have been identified in multiple studies (Handelsman & Gupta, 1997; Kindlundh et al., 2001; Miller et al., 2002; Wichstrom &

Pedersen, 2001). AAS use is associated with the use of prescription tranquilisers/sedatives, other illicit drugs, alcohol and tobacco (Kindlundh et al., 2001; Miller et al., 2002; Nilsson et al., 2004; Wichstrom & Pedersen, 2001). Adolescents who use AAS have been found to be less likely to believe AAS are harmful, less concerned about their health and less knowledgeable about healthy nutrition (Nilsson et al 2004; Irving et al 2002). Poorer rates of self esteem, weight loss concerns, disordered eating, higher rates of depression and higher rates of attempted suicide have also been identified among adolescent AAS users (Irving et al., 2002; Kindlundh et al., 2001; Miller et al., 2002; Nilsson et al., 2004; Wichstrom & Pedersen, 2001). Bearing in mind that the prevalence of AAS use among adolescents is low compared to other illicit drugs use (between 1 and 4% in males and between 0 and 2% in females), the prevalence of these kinds of behaviour is also low. However, taken together, these findings may indicate that AAS use is part of a wider adolescent problem behaviour syndrome (Miller et al., 2002).

Adding weight to the theory of a problem-behaviour syndrome in adolescents, a study by Pedersen et al (2001) examined the relationships between adolescent AAS use, violence and victimisation in detail. Adolescents in social circles where AAS (and similar substances) are present (measured as having been offered doping agents) often report violent behaviours. The investigators found that there was no additional effect of actual use of doping agents. So, AAS might not be a direct causal factor in the aetiology of adolescent violence, but might serve as a marker of a violent subculture of adolescents. Similar patterns were found with respect to victimisation: there were associations between the exposure to AAS (or similar substances) and victimisation in both genders but no additional effects from the actual use of such substances (Pedersen, Wichstrom, & Blekesaune, 2001).

A different picture, however, was formed for the most serious and violent forms of victimisation: boys in social circles where AAS or similar substances were used became victims of violent victimisation more often than other boys, and there was an association with actual use of doping agents. Pedersen et al (2001) suggest that AAS use may result in a big and muscular appearance that makes the user more visible in public and a target for youth violence.

On the one hand, there appears to be a good deal of evidence in the form of social, developmental and peer pressure to support the view that anxiety concerning body image in males can and does exist. In addition, adolescent AAS use has been found to be associated with average/low self-esteem, and users are more likely to be preoccupied with body shape and be more dissatisfied with the appearance of their shoulders (Kindlundh et al 2001; Irving et al 2002).

However, the current research also seems to indicate that adolescent PIEDs use is not simply related to sports involvement or body image, but that there is a range of complex socio-cultural and developmental factors that may contribute to adolescent use.

## 4. Conclusions

The prevalence of non-medical use of PIEDs is likely to be under-reported in Australia. Regular AAS users report that their use is heavily stigmatised (Monaghan, 1999, 2002c; Wright et al., 2000). Surveys such as the National Drug Strategy Household Survey (NDSHS) ask about AAS use in the context of other illicit drug use – this is an issue since many in the bodybuilding and gym community do not identify their PIEDs use as “recreational” or “illicit” drug use. Community surveys also assume that PIEDs prevalence is distributed equally across geographical locations, which is probably not the case. There may be some suburbs or communities in which there are higher rates of use.

There is a range of PIEDs being used for a variety of reasons. For example, PIEDs are used to enhance muscle size, muscle definition and fat loss, to circumvent testing (masking) and to manage side effects of AAS use. Most PIEDs have legitimate medical applications. However, there are medicines being used without medical supervision and for entirely different purposes to their intended uses (e.g. the use of anti-oestrogens, HCG, insulin and clenbuterol). In addition, there is an increasing range of untested sports and bodybuilding ‘supplements’.

There is still lively debate regarding whether or not the perceived benefits of some PIEDs have scientific merit. In the case of AAS, there is now good evidence that supra-physiological doses of AAS can increase lean muscle mass. However, some of the reported benefits of other PIEDs remain untested.

Although elite sports use of PIEDs has had a high profile in the media, there are a number of other groups of users who have received less attention. For example, young men, gay men, competitive bodybuilders, men who train with weights, and security guards are just some of the groups discussed here. Individual motivations and functions of use vary greatly. Although there may be increasing numbers of women who use AAS and other PIEDs, the majority of AAS users remain male.

Recent research indicates that a growing number of men have body image concerns. Once we understand the body image concerns of men in terms of the ‘drive for muscularity’, rather than the ‘drive for thinness’, body image concerns among men of all ages appears widespread. The pressure to ‘look good’ seems to be both internal and external. The ‘masculine’ physique of broad shoulders, muscular arms, v-shaped torso with a ‘6-pack’ abdomen has become a familiar

ideal in the media. Body image and appearance are increasingly being identified as major motivational factors for non-medical PIEDs use. However, the current debate is about what constitutes 'normal' body image concerns and/or competitive sporting behaviour, and how we distinguish 'normal' behaviours from psychological disorders.

A group who have been frequently identified as at risk through PIEDs use is adolescents. Adolescents are believed to be even more in tune with the socio-cultural and media-driven 'ideal' male physique, and perhaps more vulnerable to PIEDs use. The prevalence of non-medical AAS use among adolescents certainly appears to be higher than that found among the general population. While there is evidence that adolescent PIEDs use is associated with involvement in power sports and having a poorer body image, there is also evidence that adolescent AAS use is part of a wider problem behaviour syndrome (Miller et al., 2002).

PIEDs use is challenging for health professionals: using these substances appears to contradict otherwise healthy lifestyles and rigorous training activities. In Australia, where obesity rates have more than doubled over the last twenty years, health messages are focusing on the importance of health, weight and fitness. But, seemingly in contradiction, men are using PIEDs in order to help achieve an increase in 'fat free mass' and to project what is believed to be a 'healthy' appearance. Concepts such as 'cycling', 'stacking', 'bulking', 'cutting' and 'synergy' for the purposes of muscle enhancement remain grounded in street talk and anecdotal evidence, and remain untested in scientific research. These are basic premises for the non-medical AAS user and cycles are planned on the basis of these strongly held beliefs.

The other challenge for health professionals has been a tendency, particularly with non-medical AAS use, to overstate the harms. The most common side effects of non-medical use of AAS include acne, reduction in testis size in men, abnormal breast development (gynecomastia) in men, masculinisation in women and children, abnormal liver function (elevated enzymes), injection site pain and alteration of blood constituents. It is widely accepted that the greatest harms are associated with the use of the 17 $\alpha$ -alkylated AAS compounds. In addition, it is possible that AAS use changes the risk factors for cardiovascular disease, liver tumours, infertility, and other organ damage. While the evidence is less conclusive, there are other areas of concern including cardiomyopathy, coronary artery disease, cerebrovascular accidents, epiphyseal closure in children (prematurely halting normal growth), prostatic changes and changes in immune functioning. There are a range of possible effects on mood and behaviour. PIEDs use has been associated with changes in sex drive, increases in irritability and aggression, impulsivity, mania, hypomania,

depression, paranoia and sleep disorders. Some PIEDs users may experience symptoms of dependence.

The harms relating to the use of hGH and IGF-1 are possibly acromegaly and diabetes. The harms relating to insulin are potentially very serious: rapid drops in blood sugar can cause confusion, coma and, if untreated, death. Clenbuterol is known to cause tremors, restlessness, heart palpitations and anxiety, and there are case reports of accidental poisoning (from meat products and from 'fake' PIEDs). The risks associated with the non-medical use of anti-oestrogens have not been examined. There is very little or no data on the harms associated with the non-medical use of 'other PIEDs'.

Although there are commonalities, PIEDs (and AAS in particular) do not fit neatly into our current frameworks for understanding 'body image distortion' or 'drugs of dependence'. Non-sporting AAS use among some individuals may be due to underlying clinical issues (such as body dysmorphic disorder), although not all AAS users display low self-esteem or dissatisfaction with their appearance. Similarly, some AAS use fits our understanding of illicit drug use and dependence (where patterns of use involve constant mega-dose regimes and cause significant social impairment), but not all AAS users fit this pattern of use. Most commonly, AAS are used in 6-12 week cycles followed by rest periods of equal length or longer – this is a very different pattern of use to other drugs of dependence. Many users do not report serious harms (either physical, social or psychological) and most feel that the benefits of use outweigh the risks (O'Sullivan et al., 2000; Peters et al., 1999).

Bearing in mind that most PIEDs mimic hormones and their precursors, the most likely harms will arise from the disruption and suppression of natural hormonal and metabolic systems. While there are case reports in the literature of sudden deaths and adverse events associated with PIEDs use, it has been difficult to establish whether this is due to any one substance, polydrug interactions or idiosyncratic responses. Each of the substances discussed here has the potential for unwanted side effects, even in clinical settings. Intuitively, transferring these substances to naturalistic settings of non-medical use might see these risks increase. Anecdotal advice is often that intermittent use, with lengthy rest periods, may protect from serious long-term side effects and harms. In the absence of objective supporting data, these assertions cannot be accepted at face value. While the overall incidence of serious or fatal complications may be low, there are likely to be some negative health and psychological effects. The potential harms of long-term use of PIEDs need to be investigated in greater detail.

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