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THE USE OF ANABOLIC ANDROGENIC STEROIDS AS A PUBLIC HEALTH ISSUE

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ABSTRACT

In recent years there have been increasing calls for the use of anabolic steroids and associated drugs to be recognised as a public health issue. Once the domain of the competitive athlete and professional bodybuilder, recent decades have seen the diffusion of AAS from the hardcore gyms of the 1980s and 1990s to the mainstream exercise and fitness environments of the 21st century. Alongside the apparent increases in the use of these drugs, there is a growing evidence base in relation to harms - physical, psychological and (to some extent) social. But is this form of drug use a public health issue? What criteria should we use to make this judgement? What is the available evidence and has our understanding of the issue improved?

By drawing on the authors' research in the United Kingdom (UK) and the wider international literature this chapter will explore these issues and attempt to answer the fundamental question - is the use of anabolic steroids a public health issue?

KEYWORDS:

1. Anabolic androgenic steroids
2. Image and performance enhancing drugs
3. Public health
4. Harm reduction
5. Evidence review

Criteria and definitions

This chapter will examine the growing recognition of doping within the general population as a public health issue. The focus will be on the use of anabolic androgenic steroids (AAS), however this term will also be used to include a range of additional drugs that are used as anabolic agents (e.g. human growth hormone, insulin, growth hormone releasing peptides), prevent or mitigate the adverse effects of AAS (e.g. tamoxifen, human chorionic gonadotrophin) or promote weight loss (e.g. dinitrophenol, clenbuterol). Over the years, many different substances have entered the repertoire of drugs used for muscular enhancement (McVeigh, Salinas, & Ralphs, 2020). For instance, human growth hormone has steadily increased in popularity, from use by competitive athletes and elite bodybuilders in the 1980s, to become easily available and commonly used within gyms around the world (Brennan, Wells, & Van Hout, 2017; Evans-Brown & McVeigh, 2009; Holt & Ho, 2019). Some drugs have maintained a level of use despite scant evidence of effectiveness, for example gamma hydroxybutyrate (GHB) (Takahara et al., 1977), taken to enhance the release of human growth hormone (Assael, 2007; McVeigh et al., 2020). While for other drugs, use has been transient, for instance, nalbuphine hydrochloride (Nubain©) gained popularity for a relatively short period in the 1990s based on an unfounded reputation for having anti-catabolic properties (Duchaine, 1988; Wines, Gruber, Pope, & Lukas, 1999) and is now rarely reported as being used (Begley et al., 2017; McBride, Williamson, & Petersen, 1996; McElrath & Connolly, 2006) However, while various drugs have gained popularity with those looking to enhance musculature, the AAS have remained a constant feature and the basis of drug regimens for muscular enhancement around the world (Bonnecaze, O'Connor, & Aloï, 2020; Cohen, Collins, Darkes, & Gwartney, 2007).

It is important to recognise that this chapter relates predominantly to the situation in the United Kingdom. While much of the international evidence relating to the use of AAS is generalisable, for example the pharmacological actions and associated harms, the situation in the UK is unique in relation to its policy response to this form of substance use. When AAS and associated drugs were

brought under control of the Misuse of Drugs Act (1971) during the 1990s, personal possession remained legal and only the manufacture, distribution, and possession with intent to supply were categorised as class C offences (Druglink, 1993). The rationale for this decision, as stated by the Advisory Council on the Misuse of Drugs, was to avoid driving AAS further underground and to avoid criminalising large numbers of young men (ACMD, 2010b). This approach has continued following subsequent reviews by the ACMD, who advocate a public health approach to preventing or mitigating the harms associated with AAS use. Globally, no other country has significant criminal penalties for supply offences (up to 14 years and an unlimited fine) but no personal possession offence, and a comprehensive network of NSPs available to AAS users (Henning & Andreasson, 2020; McVeigh & Begley, 2017).

This chapter will examine the evidence relating to the use of AAS and associated IPED use in the UK. Specifically, we will look at the epidemiology, motivations for use, range of potential harms and the public policy responses, in an attempt to answer the question: ***is the use of anabolic steroids a public health issue?*** This chapter builds upon and for the first time publishes the ongoing work of the lead author. Since commencing work on this topic in the early 1990s, McVeigh has collated the relevant published academic work on the use of AAS and associated IPED use in the UK on an annual basis. The “state of the evidence base” has then been informally summarised at various times for inclusion in conference presentations and lectures. In collaboration with the co-authors and through discussion to find consensus, this process has been refined to identify “state of the evidence base” at the end of each decade. The intention, is to not only answer the question ***is the use of anabolic steroids a public health issue?*** but to pose the question in relation to the categories of evidence ***“are we there yet?”*** The chapter will discuss the required criteria for defining the use of AAS as a public health issue before grading our current understanding of each of the criterion. We will then summarise the evidence that informed our decision

Background

Since the identification and synthesis of testosterone in the 1930s, numerous variations of the hormone have been developed (although many have never been commercially developed, forming the 'family' of AAS (for further details see <https://www.anabolicsteroids.org.uk/anabolic-steroids-and-associated-drugs/>). All possess both anabolic (muscle-building) properties and androgenic (masculinising) properties (Kanayama & Pope, 2018), with their potential for performance enhancement in sport being recognised by the 1950s, particularly those sports relying on power and strength (Dimeo, 2007; Kruskemper, 1968; Voy & Deeter, 1991). The use of AAS within the gym culture was well established in parts of the United States by the 1970s (Evans-Brown, McVeigh, Perkins, & Bellis, 2012; Hoberman & Yesalis, 1995) and relatively common in parts of the UK by the late 1980s (P Lenehan & McVeigh, 1997).

The last 30 years has seen unprecedented advances in pharmacology and technology, not least, the expansion of the Internet resulting in increased availability and affordability of human enhancement drugs (Evans-Brown et al., 2012). Alongside our technological advances, our society has a dwindling requirement for physical size and strength in our everyday lives, however, this has not diminished the drive for muscularity amongst sections of the population. For some, the physical transformation through increased musculature has the potential to change their relationship and interaction with the world around them (Ask Vest Christiansen, 2019). This powerful motivation, among a complex environment of factors at an individual, social, institutional, community and societal level have contributed to the widespread use AAS (Bates, Tod, Leavey, & McVeigh, 2018). Those choosing to use AAS are by no means a homogenous group, not only in their drivers and motivations for use but in their behaviours and associated risks (Christiansen, Vinther, & Liokaftos, 2016; Zahnow et al., 2018) These risk behaviours are diverse, some associated with maximising muscle growth through a broad pharmacopeia of substances (Sagoe et al., 2015) or extremely high dosages for prolonged periods (Chandler & McVeigh, 2014) while others may be linked to broader lifestyle choices as psychoactive drug use, risky sexual behaviour (Hope et al., 2013).

What constitutes a public health issue?

There are no predetermined criteria to be met or formal grading by which we can define a public health issue in the UK. A public health issue is often characterised as a specific infectious agent causing an immediate impact on a substantial section of the population. Person-to-person transmission is not necessary to have a public health threat. Food safety, sanitation, water fluoridation, insect and vermin control, and pollution control are examples of public health issues for which measures have been taken to address health threats to the public (Rothstein, 2002). Alongside these examples are a range of behaviours which may be considered a public health issue, including substance use (Ashton & Seymour, 2010). It is within this context that we examine the use of AAS, consider the associated behaviours, and judge if they cross a threshold to be classed as a public health issue. In general terms it is a basic assessment of the severity of harm at a population level. The recognition of AAS as a public health issue is the first stage of developing effective interventions. There are a range of public health intervention models, incorporating the identification of risk and protective factors, the testing of interventions and the implementation of effective programmes (Centers for Disease Control and Prevention, 2021; Wight, Wimbush, Jepson, & Doi, 2016). However, they all require the problem to be initially defined and the collation of available epidemiological data relating to prevalence, characteristics, and behaviours.

To monitor our recognition of AAS as a growing public health issue, McVeigh has recorded his subjective opinion relating to our understanding of AAS across a number of specific areas of concern since commencing research in this field in the early 1990s. The headings reflect the domains required to form a basic assessment of AAS as a public health issue. The four domains incorporating nine categories were derived to summarise our understanding of the phenomenon of AAS use, its potential for causing harms and the development of interventions (e.g. the prevention of initiation of use, the mitigation of adverse effects, support for the cessation of use).

While the following table and key for grading evidence is subjective and shaped by the author's personal view of the evolving evidence base, it does provide a consistent assessment over time of the size of the issue and the potential harms, sometimes referred to as the magnitude and severity of an issue (Rychetnik, Hawe, Waters, Barratt, & Frommer, 2004), the two primary criteria in the assessment of public health importance (World Health Organization, 1997) together with the progress in developing effective responses. . Based on the published literature, the strength of evidence was assessed for each of the nine categories, providing a structure to examine this broad and complex topic. Where evidence was available, each category was assigned to one of four categories reflecting the strength of the evidence base.

Table 1 Review of the anabolic androgenic steroid evidence base 1999- 2019

Key to grading of evidence

- No evidence (No evidence) = no evidence available.
- Very weak (very little, very limited, etc) = evidence from very small number of studies only or methodological quality of evidence is very poor.
- Weak (early stages, basics) = evidence is inconsistent, methodologically weak, or considerable gaps remain.
- Moderate (Good, data to debate) = evidence from a range of studies but lacking in consistency or quality.
- Strong (Realisation, confident) = consistent and comprehensive evidence base.

Table 1 provides the author's perception of the strength of evidence at the end of 1999, 2009 and 2019. While the level of evidence and understanding of these key elements relating AAS has undoubtedly increased over time, in several cases this has led to an appreciation that the issue is far more complex than previously recognised and the confidence of what we "know" has diminished.

However, this provides a basic framework to assess the use of AAS and conclude if we have the evidence to suggest that this is a public health issue by considering AAS use against the nine included criteria. One glaring omission from the outset of these reflections is the “illicit market” and the public health consequences of the uncontrolled, illegal supply of AAS and associated drugs. This point will be reflected upon following the examination of the nine areas indicated in table 1. These will be considered under the groupings of epidemiology, motivations and methods, harms and effective responses respectively.

Epidemiology

For AAS to be considered a public health issue it must either impact on a significant proportion of the population or be increasing at a rate that will impact significant numbers of the population. Estimating the number of people engaged in clandestine behaviours is notoriously difficult and at present we do not have robust estimates of AAS prevalence for the UK, although outputs from a current research programme will provide the foundation for these calculations (McVeigh, 2021). Even without robust prevalence estimations, there are clear indications at both national level in the UK and through global meta-analysis to justify public concerns regarding the levels of use. In the UK, the Crime Survey for England and Wales (CSES), and its forerunner, the British Crime Survey, produces estimates of drug use, however these are recognised as a gross under representation of AAS use (ACMD, 2010b). That said, they estimated in excess of a quarter of a million people had used AAS in England and Wales during the lifetime (Office for National Statistics, 2021). Meanwhile, in the United States it has been estimated that between 2.9 and 4.0 million people had used AAS at some time in their lives (Pope, Kanayama, et al., 2014). Drawing on studies from around the world, a global estimate has been calculated as lifetime prevalence of 3.3% (men: 6.4%, women: 1.6%), with higher rates in Western societies, the Middle East, and South America (Sagoe & Pallesen, 2018). Caution is required when interpreting these prevalence estimates, with some of the confounding factors well documented (e.g. gaining access to a clandestine AAS culture, the limitations of a

household survey and practicalities of accessing a population who are predominantly working full time and spending a considerable amount of time in the gym) (ACMD, 2010b; Kanayama & Pope, 2018; Sagoe & Pallesen, 2018). However, even allowing for the limitations within these estimates, these studies demonstrate the magnitude of the use of AAS, clearly illustrating that the issue reaches the threshold of impacting on substantial numbers of general population and therefore potentially a public health issue. Current work being undertaken by academics in the United Kingdom aims to strengthen our understanding of the extent of AAS use. Funded by the National Institute for Health Research (NIHR), the work utilises two approaches, secondary analyses of available UK data (including CSEW, NSP data, United Kingdom Anti-Doping data, and private injecting equipment sales), together with a Delphi survey technique, capturing the expertise and experience of a broad range of experts and stakeholders (McVeigh, 2021). This work will produce a plausible range of the extent of use and form the basis for the estimation of AAS and IPED use in the UK and have implications for prevalence estimates in other countries.

All evidence points towards a disproportionately high level of use amongst men compared to women in the UK (Begley et al., 2017; Hope et al., 2013; Korkia & Stimson, 1993) and internationally (Sagoe, Andreassen, & Pallesen, 2014) and this is reflected in the focus of much of the published research. However, while prevalence is much lower in women, harms can be significantly greater (Havnes, Jorstad, Innerdal, & Bjornebekk, 2020). Notably, media interest has focused on young men rather than their older male counterparts, often attributing perceived increases in the use of AAS to specific television programmes despite the lack of epidemiological evidence to support this (Hamilton & Sumnall, 2017). While much of the epidemiological work of the 1980s, particularly in the USA, focused on young males (teenaged and early 20s) and the use of AAS (Buckley & Yesalis, 1989; Buckley et al., 1988; H. G. Pope, Katz, & Champoux, 1988; Yesalis et al., 1989), recent evidence also indicates use in later life. A recent UK survey identified as many people using AAS in the 40+ age group as those in the under 25s (Begley et al., 2017). Similarly, data from NSPs show an increasing

average age of clients using AAS (McVeigh & Begley, 2017). Little research has been conducted regarding the use of AAS within Black, Asian and Minority Ethnic communities. While one small study identified significant differences relating to supply and use of AAS within British South Asian community (Van Hout & Kean, 2015), there is a clear need for further research to inform policy and practice.

Clearly, the number and sophistication of epidemiological studies on AAS has increased over time however, we have unearthed a more diverse picture of use than previously recognised. Use is not restricted to gender age, race, sexuality or socio-economic group. While we can say with confidence that AAS use is disproportionately higher amongst males, even this must be qualified with evidence of high use of weight loss and tanning agents by women (Germain, McLean, & Leavey, 2019). Rather than an easily identifiable group of young hyper-muscular men, (although this group of users still clearly exists (Goldman, Pope, & Bhasin, 2018)), the use of AAS or associated IPEDs has been identified wherever and amongst whomever have been researched resulting in the recognition of a much more complex epidemiological landscape, which we are at only the early stages of exploration.

Motivations and methods of use

Closely associated to the diversity of populations of AAS users, is the range of motivations for use. Building on the classifications of AAS users of the 1990s (Dawson, 2001; Lenehan & McVeigh, 1998), a typology of AAS in the 21st century has been developed (Christiansen et al., 2016). Utilising previously collected qualitative interview data and supplemented by the observations of the authors, four ideal types of users were identified based on the effectiveness of AAS use and associated risks: the Expert type, the Well-being type, the “YOLO” type and the Athlete. Using the data from the National IPED study (Bates & McVeigh, 2016) and working with colleagues in the UK and Australia, detailed cluster analyses and logistic regression were conducted and published

(Zahnow et al., 2018). Findings closely reflected the four categories hypothesised by Christiansen et al., (2016).

While the aforementioned US prevalence studies of AAS use identified young males as the predominant group, this was closely aligned to sporting ambition at either high school (Buckley et al., 1988) or college level (Pope et al., 1988), current research illustrates a more complex picture. With the identification of older men who use AAS it appears that for some, this represents a prolonged career of 20 years use or more while for others, the decision to use AAS has been taken in later life, (Havnes, Jorstad, & Wisloff, 2019), in one case at the age of 69 (Ip et al., 2015). The most recent UK national survey of IPED use provides some insight to the varied motivations of use, illustrating a complex picture of multiple rationales and ambitions for use. Of the total sample of 684 people using AAS, 6.5% were highly motivated by wanting to maintain a youthful appearance while 7.8% of the sample were using as a form of self-directed hormone replacement therapy (Begley et al., 2017).

While we propose that the use of AAS is a public health issue, it is also (at least for some) a sports issue. The latest UK national survey of IPED use demonstrates the diversity of motivations for use. While 27% of the sample felt that AAS was very important for their sporting performance (excluding bodybuilding), 33% felt it was unimportant. So, while the majority of users felt AAS use was very important for their cosmetic appearance/body image (56%), others felt it very important for sex drive (8.4%), occupational performance (10%) and competitive bodybuilding (22%) (Begley et al., 2017).

Over time there has been a gradual recognition of the multiple subgroups of users and complex reasons for the use of AAS and associated drugs. In the 1990s there was a confidence within policy and legislation on both sides of the Atlantic, that AAS use was driven by competitive sport (including

bodybuilding) (Hansard, 1996; Anabolic steroid Act, 1990). Recently there has been a broadening of our understanding and an appreciation of the extent and variation of use of these substances. The complexity of AAS use highlighted by the broad range of motivating and influencing factors, substances used, and associated behaviours amongst diverse subgroups supports our understanding that AAS use is a public health issue. With the vast majority of IPED research focused on anabolic steroid use by males, we have even less data to guide a public health approach when we examine the use of drugs other than AAS (for example, human growth hormone and a range of other peptide hormones or clenbuterol etc. or the use of AAS by women).

Harms

A key element in the recognition of AAS use as a public health issue is the identification of the extent and severity of actual or potential harms caused. These harms may be described as either direct or indirect harms.

Anabolic androgenic steroids and direct harms

Direct harms are those adverse consequences directly linked to the pharmacological effects of the drugs. As with much of our knowledge regarding AAS use, the majority of data relating to direct health harms are derived from “weak evidence”, that is, case reports/series and cross-sectional studies that are observational in nature, limiting their application to population based health (Evans-Brown, Kimergard, & McVeigh, 2009). However, since testosterone was first popularised in the twentieth century (de Kruif, 1945) we have gained an understanding of the drugs mechanisms of action and therefore the organs and systems of the body which are most likely to be damaged. These well-established deleterious effects may be described as cardiovascular effects, haematologic effects, psychiatric and neuropsychologic effects, and hormonal and metabolic effects (ACMD, 2010a; Pope, Wood, et al., 2014). Example of the harms that AAS may cause to specific organs and systems can be seen in Table 2.

Table 2: Conditions commonly attributed to the use of anabolic androgenic steroids

As is often the case within AAS research and published literature the data in Table 2 uses the male as the template for harms e.g. the neuroendocrine condition of gynaecomastia, caused by increased levels of oestrogen in men, in this case due to aromatisation of excess testosterone (Niewoehner & Schorer, 2008). For women the neuroendocrine effect of virilisation results in masculinisation, gonadal and sexual effects (Havnes et al., 2020). While it remains an under-researched area of AAS use, there is compelling evidence that in addition to the adverse effects common to men women experience the additional masculinisation of increased facial and body hair, deeper voice, reduced breast volume, enlarged clitoris, irregular/absent menstruation and reduced fertility (Andreasson & Henning, 2021; Borjesson, Garevik, Dahl, Rane, & Ekstrom, 2016; Korkia, Lenehan, & McVeigh, 1996; Strauss, Liggett, & Lanese, 1985).

In recent years, much of the research regarding the direct harms relating to AAS has been confirmatory in nature, for example, the growing evidence base related to mechanisms associated with untoward cardiovascular events and AAS (Bigi et al., 2020; McCullough et al., 2020; Sidelmann, Gram, Rasmussen, & Kistorp, 2021). A notable exception to this is the growing evidence base in relation to the effects of AAS and the brain. Descriptions of the psychological effects AAS is rooted in the 1980s and 1990s e.g. personality disorder (Cooper, Noakes, Dunne, Lambert, & Rochford, 1996), narcissism (Porcerelli & Sandler, 1995) and impulsivity (Pope & Katz, 1992), and continues in current research (Aknouche, Gheddar, Kernalleguen, Maruejouis, & Kintz, 2021; Chegeni, Pallesen, McVeigh, & Sagoe, 2021; Hauger, Havnes, Jorstad, & Bjornebekk, 2021; Pope Kanayama, Hudson, & Kaufman, 2021). However, it is the evidence of structural changes to the brain that provides a compelling explanation of the mechanism of action of AAS (Bjornebekk et al., 2021; Bjornebekk et al., 2017; Westlye, Kaufmann, Alnaes, Hullstein, & Bjornebekk, 2017), leading to changes in cognitive performance (Bjornebekk et al., 2019), dependence (Hauger, Westlye, Fjell, Walhovd, & Bjornebekk,

2019) and the ultimate impact on public health. The relationship between these changes to the brain, dependence, cognitive function and antisocial behaviour (including aggression) are complex, requiring ongoing research. However, these findings and their potential impact on communities have implications for society as a whole, adding considerable weight to the argument that AAS is now a public health issue.

Indirect harm

Indirect harms associated with AAS are those untoward effects other than the pharmacological actions on the drugs. The presence of blood borne viruses (BBV) amongst AAS users is an issue that has been identified within the last decade, although not uniformly recognised as a public health concern. Until relatively recently, cases of HIV or viral hepatitis amongst AAS users were extremely rare within the literature (Cook et al., 2000; Henrion, Mandelbrot, & Delfieu, 1992; Scott & Scott, 1989; Sklarek et al., 1984). While the potential for transmission was clear (Dickinson & Rich, 1996; Midgley et al., 2000), the prevalence of BBV amongst people who use AAS was generally considered relatively low (Crampin et al., 1998; Day, Topp, Iversen, Maher, & Collaboration of Australian, 2008), although issues related to local infection have been a consistent concern (Hope et al., 2015). However, this changed with the publication of the largest study of blood-borne viruses among people who use AAS, identifying a similar prevalence of HIV amongst this cohort as that observed in people who inject psychoactive drugs (Hope et al., 2013). Subsequent work supported this finding, indicating the enduring presence of HIV amongst people who inject AAS and associated IPEDs (Hope et al., 2016). Furthermore, research has also identified elevated levels of hepatitis C within this population (Hope & Iversen, 2019; Hope et al., 2016; Hope et al., 2013), often remaining undiagnosed (Hope et al., 2020; Hope et al., 2017). However, while the presence of BBV amongst populations who use AAS is unclear the route of transmission remains unclear, with sharing of injecting equipment during previous psychoactive drug injecting behaviour or sexual transmission likely routes of at least some infections (Hope & Iversen, 2019; Hope et al., 2013). This lack of clarity

regarding the transmission of BBV has contributed to the dismissal of BBV as a public health concern amongst some users of AAS and the argument that this should not be a focus of harm reduction (Underwood, 2019), however the presence of BBV within at least some populations of people who use AAS is a genuine cause for concern (McVeigh, 2019).

Issues related to the illicit market were an omission from the initial assessment of the AAS evidence base in 1999 and therefore subsequent reviews (table 1). However, the illicit market can result in negative consequences for people who use AAS so will be considered here, under the domain *indirect harms*. As this chapter is focussed primarily on the UK the specific harms associated with the criminalisation and potential imprisonment of people who use AAS will not be considered due to the specific UK legislation and the decision to exclude personal possession as a criminal offence, a situation in stark contrast to countries such as Australia (Van de Ven & Zahnow, 2017). However, the illicit market can still have a profound negative impact on health. The uncontrolled illicit market and inevitable sale of substandard products has long been an issue (Duchaine, 1989; Korkia & Stimson, 1993; McVeigh & Lenehan, 1994). However, over time as the availability of legitimately manufactured products has decreased the market has seen an influx of products purportedly manufactured in countries such as China, often of questionable quality (Evans-Brown et al., 2009). In the absence of systematic purchasing and testing of products, a reliance on convenience samples provides an inexact picture of the extent of the issue (Fabresse et al., 2021; Graham et al., 2009; Shapira, Poperno, Arieli, & Berkovitz, 2018) and therefore the actual harms. However, with examples of gross misrepresentation of drugs, inexact dosages and high levels of contamination (Breindahl et al., 2015; Kimergard, Breindahl, Hindersson, & McVeigh, 2014; Kimergard, McVeigh, Knutsson, Breindahl, & Stensballe, 2014; Stensballe, McVeigh, Breindahl, & Kimergard, 2015) it is clear that the illicit market presents significant challenges to public health.

Effective responses

The final section on AAS and its recognition as a public health issue relates to the effective prevention, treatment, and harm reduction associated with use. There remains a dearth of evidence in relation to effective interventions to prevent the onset of AAS use, mitigate the harms associated with use or support the successful cessation of use. There are few studies that have examined the effectiveness of strategies to prevent the use of AAS and associated drugs. Interventions that have been evaluated are predominantly delivered within school sport settings and limited to information provision (Bates & Backhouse, 2019). They are often hampered by the short-term nature of the follow ups and a lack of robust behavioural outcome measures (Bates, Begley, et al., 2019). As we have outlined, there are diverse populations with a variety of motivations for using AAS, with this broadening further when the full range of IPEDs are concerned (McVeigh, Evans-Brown, & Bellis, 2012). It is clear that comprehensive interventions that address the complexity of the lived experience are required if prevention efforts are to be successful (Bates & Backhouse, 2019). At present, we remain some way off developing multi-layered responses with rigorous outcome measures, to reduce the initiation of this form of drug use.

Similarly, there is a lack of evidence on treating dependence, managing withdrawal, or initiating behaviour change in AAS users (Bates, Van Hout, Teck, & McVeigh, 2019). While there are plentiful case reports of complications and adverse consequences of AAS use including psychiatric, neuroendocrine, hepatic, kidney, cardiovascular, musculoskeletal and infectious, together with their clinical management, there is little evidence on the successful management of the cessation of AAS use. Similarly, since the effects of testosterone on an individual's size and strength were proven scientifically (Bhasin et al., 1996) we have made little progress in understanding the potential benefits or the optimal dosages of specific AAS either in isolation or in combination. This lack of evidence regarding the efficacy of AAS limits the possibility of providing acceptable evidence-based advice on, for example, dosage, frequency of use and cycle length to reduce the risk of harm.

The clinician, health practitioner or even peer AAS user has little scientific evidence therefore on which to base harm reduction advice or guidance, with experiential or anecdotal information of varying reliability filling the void. This lack of evidence upon which health promotion guidance can be drawn can be seen clearly regarding the issue of post cycle therapy (PCT), the practice of using drugs such as tamoxifen and human chorionic gonadotrophin (hCG) to mitigate the effects of low levels of testosterone or stimulate the production of testosterone following a course of AAS. While the potential benefits of various substances have been identified in small scale studies (Anawalt, 2019; Tan & Scally, 2009) and supported by anecdotal evidence (Griffiths, Henshaw, McKay, & Dunn, 2016; Llewellyn, 2017), there has been little research conducted in relation to PCT. In fact, in direct contradiction regarding the benefits of PCT and suggestions from a recent study of 80 users of PCT concluded that, there was hardly any evidence to support its use, that tamoxifen had negligible effects on the actions of AAS and that hCG had no detectable effect on testicular size or spermatogenesis (Smit, Buijs, de Hon, den Heijer, & de Ronde, 2021). Caution is required in the interpretation of research with relatively small sample sizes and the use of illicitly obtained medications with a lack of data on drug provenance however this illustrates the lack of progress in relation to answering a key question regarding AAS and a tenet of any harm reduction activity.

Recent publications have attempted to inform and develop the evidence base in relation to harm reduction in the UK. With a focus on health professionals and effective engagement, qualitative research has attempted to identify and contribute to the community of health practice (Atkinson et al., 2021; van de Ven, Boardley, & Chandler, 2021) and to establish the need for a broader range of harm reduction interventions to be offered to address the determinants of the varied harms associated with AAS in addition to tackling the risk of BBVs (Bates, McVeigh, & Leavey, 2021; Harvey, Parrish, van Teijlingen, & Trenoweth, 2020; Jacka et al., 2020).

Conclusion

Based on our assessment of the evidence we conclude that AAS use certainly meets the threshold to be considered a public health issue. The evidence highlights not only the extent of AAS use, but its complexity, diversity within the AAS using community, and the clear potential for harm to the AAS using community and wider population. Of concern is that despite the extent of AAS use and our understanding of associated direct and indirect harms, there remains a lack of evidence in relation to effective responses to this form of drug use. The complexity of AAS use through the diversity of the population, the nature of the illicit market, and the range of additional IPEDs used present a significant challenge to developing effective responses that will address this multifaceted issue and ultimately reduce the associated harms.

While we may be still at the early stages of gaining a comprehensive picture of the complex epidemiology of AAS, we have enough data to be concerned by the extent of this phenomenon and to be clear that it will not simply go away. We now have compelling data on the long-term harms of AAS use. We can now add concerns regarding the effects of AAS on the brain (Bjornebekk et al., 2021; Bjornebekk et al., 2017; Westlye, Kaufmann, Alnaes, Hullstein, & Bjornebekk, 2017) to the established evidence related to cardiovascular risks. While data related to blood borne viruses amongst this population are largely restricted to the UK (Hope et al., 2016; Hope & Iversen, 2019; Hope et al., 2016; Hope et al., 2013; (Hope et al., 2020; Hope et al., 2017)) this is also a cause for concern. The additional indirect harms caused by adulterated and contaminated products from the illicit market (Evans-Brown et al., 2009), merely compound the issue.

As the evidence base has developed in recent decades, it has highlighted our knowledge gaps and resulted in the recognition that this is a far more complex and multi-faceted issue than many had previously imagined.

We argue that the UK is ideally placed to develop our understanding of factors driving the use of the drugs and the regimes and behaviours employed, together with the potential harms and ultimately,

how society may implement a public health approach leading to the reduction of harm. The United Kingdom took the deliberate step of avoiding the criminalisation of AAS use (ACMD, 2010b), combining this with a network of NSPs (NICE, 2014) and the recognition that AAS and associated IPED use is an issue, that for some, requires clinical management (Clinical Guidelines on Drug Misuse and Dependence Update 2017 Independent Expert Working Group, 2017). It is within this environment that we are hopeful of seeing significant developments across all the domains of evidence in relation to AAS use in the coming decade. Furthermore, we are hopeful that new approaches to complex issues such as systems mapping (ASUK, 2021), may support our understanding of the factors that contribute to problems and that working with stakeholders, in particular those who use of AAS and associated IPEDs, will support the development of interventions that will reduce harm.

Suggested key readings.

1. **Pope HG, Jr., Wood RI, Rogol A, Nyberg F, Bowers L, Bhasin S. Adverse health consequences of performance-enhancing drugs: an Endocrine Society scientific statement. *Endocr Rev.* 2014;35(3):341-75**

This important scientific statement synthesises the available evidence on the harms associated with AAS and other commonly used IPEDs. This provides a summary of what we knew at that point and is a useful starting point for those interested in the topic including policy makers, practitioners and those using or contemplating the use of AAS or other IPEDs.

2. **Hope VD, McVeigh J, Marongiu A, Evans-Brown M, Smith J, Kimergard A, et al. Prevalence of, and risk factors for, HIV, hepatitis B and C infections among men who inject image and performance enhancing drugs: a cross-sectional study. *BMJ Open.* 2013;3(9):e003207**

Similarly, to work of Bjornebekk et al (2017), this provided evidence of the presence of blood borne viruses amongst those who use IPEDs. Although not demonstrating how the viruses were contracted, it again illustrated the presence of a previously unrecognised public health issue.

3. **McVeigh J, Begley E. Anabolic steroids in the UK: an increasing issue for public health. *Drugs-Education Prevention and Policy*. 2017;24(3):278-85.**

This paper identified the changes in the extent and patterns of anabolic steroid use in the United Kingdom between 1995 and 2015 providing an indication of the public health implications within the context of the health-related evidence base.

4. **Bjornebekk A, Walhovd KB, Jorstad ML, Due-Tonnessen P, Hullstein IR, Fjell AM. Structural Brain Imaging of Long-Term Anabolic-Androgenic Steroid Users and Nonusing Weightlifters. *Biol Psychiatry*. 2017;82(4):294-302.**

This work provided compelling evidence of a significant health issue with up until then had not been recognised. This illustrated that we were only aware of the issue that we, as the scientific community, had actively looked for.

5. **Bates G, Tod D, Leavey C, McVeigh J. An evidence-based socioecological framework to understand men's use of anabolic androgenic steroids and inform interventions in this area. *Drugs: Education, Prevention and Policy*. 2018;26(6):484-92.**

This work provided a framework to view complex behaviours associated with AAS use together with the many influential environments and relationships that impact on a diverse population, in different ways and at different times. This was the basis of the subsequent systems mapping approach to considering the issues associated with the use of AAS.

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