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Use of anabolic androgenic steroids in substance abusers arrested for crime

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ABSTRACT

Background: Use of anabolic androgenic steroids (AASs) has been associated with both violent crime and the use of illicit drugs. The scientific literature on polysubstance abuse as a confounder for AAS-related violence is sparse and ambiguous. With the intent of further investigating this issue, we have gathered data concerning drug abuse and AAS experience among substance abusers who have been arrested for a variety of crimes.
Methods: Data were collected from structured interviews with substance abusers ($n = 3597$) apprehended at two remand prisons in Sweden from 2002 through 2008. Analyses concerned type of criminal act, primary drug used during the past year, and experience of AAS use.
Results: Those stating AAS experience ($n = 924$, 20 women and 904 men) were more often apprehended for violent crimes (OR = 1.65). This association remained significant after controlling for age and sex (OR = 1.28). AAS users and non-users claimed similar primary substances of use during the past year, with the exception of benzodiazepine use, which was more common in the AAS group (OR = 2.30), although this did not affect the frequency of violent crime. Among AAS-experienced participants, there was no difference in violent crime incidence between current users and former users.
Conclusions: Study results suggest that AASs do not function as a proximal trigger for violence but still involve an increased risk for violence in users of illicit drugs. These findings also suggest that AAS use is highly overrepresented in women who commit crimes.

1. Introduction

1.1. AAS

The term anabolic androgenic steroid (AAS) refers to the male sex hormone testosterone and structurally and functionally related synthetic compounds. AASs have anabolic (muscle-building) and androgenic (development and maintenance of secondary male characteristics) properties (Handelsman, 2006; Marshall, 1988). The use of non-prescribed AASs spread among elite athletes in the 1950s and to other categories in society in the early 1980s (Kanayama et al., 2009b). Other categories include adolescents and young adults who train for aesthetic reasons (Nilsson et al., 2005; Parkinson and Evans, 2006), criminals (Beaver et al., 2008; Klotz et al., 2006), and polysubstance abusers (Kanayama et al., 2009a; Skarberg et al., 2009). During the most recent decades, the lifetime prevalence of AAS use in different Western societies has usually been 1–6%, with a clear dominance of male users. Studies of gym populations report prevalence figures as high as 38% (Thiblin and Petersson, 2005).

1.2. Motives for AAS usage

Most AAS users report that the purpose of use is to improve training results and to obtain a well-shaped body (Kindlundh et al., 1998; Parkinson and Evans, 2006). Other reported effects that AAS users try to obtain are enhanced libido and a sense of well-being (Cohen et al., 2007). A recent Swedish study of 45 AAS-using criminals found that 18 (56%) of those who combined AAS and other drugs did not perform muscle-enhancing training, which was also the case for four persons who had isolated use of AAS (Gårevik and Rane, 2010). The authors suggest that the purpose for using AAS without weight training might be to benefit from AAS-related aggressiveness, such as disinhibition when committing criminal acts, or the anabolic effects that exist even without weight training.

1.3. Adverse effects of AAS

AAS use has been associated with a wide range of somatic and psychiatric complications. Commonly reported physical side effects are skin lesions (severe acne, abscess at site of injection,

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and striae), water retention/edema, cardiac palpitations, decreased fertility, and sexual dysfunction (Quaglio et al., 2009). Examples of more severe and sometimes potentially lethal side effects that have been proposed are myocardial infarction, cardiac left ventricle hypertrophy, cardiac dysrhythmia, pulmonary embolism, and hepatic cancer (Maravelias et al., 2005). Psychiatric side effects, such as mood swings, irritability, aggression, hostility, and depression, have also been associated with AAS (Kanayama et al., 2008; Petersson et al., 2006a; Pope and Koenig, 2005; Su et al., 1993). There are also observations suggesting an enhanced risk of unnatural death by committing suicide or being the victim of homicide (Brower et al., 1989; Petersson et al., 2006b; Thiblin et al., 2000).

1.4. AAS violence and substance abuse

As mentioned above, AAS use has been associated with increased levels of aggression, and there are observations suggesting that AAS-related aggression may occasionally lead to physical violence (Choi and Pope, 1994; Conacher and Workman, 1989; Pagonis et al., 2006; Pope and Katz, 1990; Thiblin et al., 1997). However, reports on AAS-related violence are almost entirely derived from case reports, and a causal relationship between AAS and violence has proven difficult to establish (Kanayama et al., 2009b). As touched upon above, there are observational studies suggesting that AASs have become part of the drug arsenal of polysubstance abusers (Bahrke et al., 2000; Buckley et al., 1988; DuRant et al., 1993; Kindlundh et al., 2001; Yesalis et al., 1997). Other studies have demonstrated that AAS use is associated to a relatively high degree with risky behaviors, such as heavy alcohol consumption, use of illicit drugs, driving without a seat belt, carrying weapons, and having unprotected sex (Denham, 2009; Middleman and DuRant, 1996). Therefore, one possible confounder of AAS-related violence would be having a risky behavior, including substance abuse.

To date, there are (to our knowledge) three different studies controlling for substance abuse that have demonstrated a statistically significant increase in risk for violent crime among AAS users (Beaver et al., 2008; Klotz et al., 2007; Petersson, 2008). However, four other studies on selected populations (three at custody or prison and one hospital-based) have failed to demonstrate an increased risk of violence in AAS-experienced subjects with a presumable high prevalence of substance abuse (Isacsson et al., 1998; Klotz et al., 2006; Klotz et al., 2010; Pope et al., 1996). However, the authors of the negative studies pointed to rather serious methodological difficulties, such as high dropout rates (custody and prison studies), probable AAS cases in the control group (hospital study), and low statistical power (prison study). There is a need for additional study of the role of AAS in risk for violent crime, with abuse of other drugs taken into consideration.

With the intent of testing the hypothesis that AAS use involves an increased risk for violent crime that is more pronounced than for other forms of substance abuse, we have gathered data concerning drug abuse and AAS experience among persons with a substance abuse problem in connection with having been arrested for a crime.

2. Methods

2.1. Site and participants

Annually, approximately 7000 individuals who are apprehended, arrested, or detained on suspicion of crime enter the Remand Prisons Huddinge and Kronoberg in Stockholm, Sweden, a city of approximately 1.3 million inhabitants. Between March 2002 and the end of 2008, 3597 inmates at the remand prisons participated in The Social Medicine Remand Prison Project, whose aim was to identify drug abuse and prevent transmission of HIV and hepatitis. The inclusion criteria for participating were drug misuse, defined as 1: having injected an illicit drug more than once after 1983, or 2: having used any kind of illicit drug more than once. Single abuse of alcohol did not meet the criteria for inclusion in the project. The participants have responded to questions about drug and sexual habits and have been offered testing for sexually transmitted diseases (STDs) and hepatitis vaccination. Data were collected and processed by the Dependency Clinic Linköping University Hospital. As of May 2009, the project has become a permanent part of the Swedish prison and probation service, registered under the name The Swedish Prison Program.

2.2. Data collection

A total of 396 women and 3201 men at the two remand prisons in Stockholm, with any form of substance misuse (except single abuse of alcohol), were included in the study. A trained nurse from The Social Remand Prison Project received a list of new custodies each day. She contacted them in their cells, and if they met the criteria for drug misuse and agreed to participate, she carried out an interview with up to 81 questions related to drug abuse and bloodborne pathogens and STDs (i.e., HIV and hepatitis). Issues concerning primary drug of use, polydrug use, age of first injection, age of last injection, and the drug most frequently used during the past year, followed by what drug was second most frequently used, were addressed. AAS use was documented by three questions: if they had any experience of using AASs (per oral, intramuscular, or intravenous administration), at what age they started (not reported here, due to too many missing values), and when they last used an AAS. Data from the interviews were organized in an Excel file, and a person would only occur once even if he or she had participated several times during the study period, usually with the first interview in the file. The file also contains demographic information, as well as criminal charges.

2.3. Statistics

Logistic regression was performed to calculate the odds ratio for committing a violent crime in the group of AAS users. Analysis with Fisher's exact test was performed to test the observed difference in the proportion of subjects reporting benzodiazepines as the main drug of abuse during the past year and the χ^2 test was used to test the difference between AAS users with and without current use of benzodiazepines regarding violent crime. Statistica 8.0 (Statsoft 2008) software and Graph Pad 3.10 (GraphPad Software Inc. 2010) were employed for the analyses.

2.4. Ethical considerations

This study was approved by the local ethical committee in Uppsala (2008/380).

3. Results

3.1. Use of AASs

From a total of 3597 participants (396 women and 3201 men), 924 (26%) reported any lifetime experience of AAS use. Twenty (2.2%) of those reporting AAS experience were women and 904 (97.8%) were men. Therefore, 5.0% of the 396 female participants and 28.1% of the 3201 male participants reported AAS experience. Female AAS users and non-users did not differ in age (mean [SD] 33.7 [6.9] vs. 36.3 [10.5] years; $p = 0.27$ by t-test, two-tailed), whereas male AAS users were significantly younger than non-users (29.1 [7.7] vs. 33.7 [10.6] years; $t_{3193} = 11.80$, $p < 0.001$). The mean interval between most recent AAS use and the time of incarceration was 4.03 years (SD 4.69, range 0–25 years). Mean age at the time of last reported AAS use in 924 users was 25.37 years (SD 6.79 range 14–54 years).

3.2. AASs and drugs of choice during the past year

AAS users and non-users were very similar in terms of reported drug of choice during the past year, with amphetamine/cocaine the most commonly reported category in both groups (37.9% and 37.4% of AAS users and non-users, respectively) followed by cannabis (23.2% and 23.5%), opiates (15.4% and 18.2%) and alcohol (10.1% and 12.3%). The only drug of choice in the past year that differed significantly between the two groups was benzodiazepines, reported by 73 (7.9%) of AAS users vs. 96 (4.0%) of non-users (OR 2.30 95% CI 1.66–3.19, $p < 0.001$ Fisher's exact test, two-tailed).

3.3. AAS use and suspected crimes

Those who reported AAS experience were significantly more likely to have been apprehended for suspected violent crime, even

Table 1
Self-reported AAS use and criminal acts in persons with AAS experience ($n = 924$) and without AAS experience ($n = 2673$) apprehended on suspicion of crimes.

Type of crime	AAS use in the past month $n = 67$	AAS use in the past year $n = 215$	AAS use in the past 1–5 years $n = 282$	AAS use >5 years ago $n = 360$	Ever used an AAS $n = 924$	Never used an AAS $n = 2673$	OR, crude (CI95%)	OR, adjusted for sex and age (CI 95%)
Violent crime	25 (37%)	82 (38%)	105 (37%)	123 (34%)	335 (36%)	687 (26%)	1.65 (1.40–1.93)	1.28 (1.08–1.51)
Sexual crime	2 (3%)	2 (1%)	3 (1%)	7 (2%)	14 (2%)	47 (2%)	[a]	
Weapons offense	1 (2%)	4 (2%)	9 (3%)	9 (3%)	23 (2%)	28 (1%)	[a]	
Drug-related crime	14 (21%)	52 (24%)	64 (23%)	77 (21%)	208 (23%)	781 (29%)	0.7 (0.59–0.84)	
Crime against property	10 (15%)	51 (24%)	68 (24%)	80 (22%)	208 (23%)	667 (25%)	[a]	
Other	15 (22%)	24 (11%)	33 (12%)	64 (18%)	136 (15%)	463 (17%)	[a]	

[a] Calculation not performed due to obvious similarity.

after adjustment for age and sex (Table 1). However, there was no apparent association between the prevalence of violent crime and the recency of AAS use (Table 1). Testing for interaction between sex and use of AAS was not significant (OR 1.56; 95% CI: 0.54–4.56, $p = 0.41$).

In the group of 72 male participants who reported AAS experience and cited benzodiazepines as their primary drug of abuse during the past year, 29 (40.3%) were apprehended for violent crime, compared with 301 out of 832 (36.2%) male participants for whom benzodiazepines were not claimed as the primary drug of abuse ($\chi^2 = 0.48$, $p = 0.49$). Only one of the 20 women reported the combination of AAS experience and benzodiazepines as the primary drug of abuse, and she was not apprehended for violent crime.

4. Discussion

4.1. Findings

The main finding of the present study was an overrepresentation of violent crime among persons who had reported AAS experience compared with those who had not reported AAS experience. This difference was independent of age and sex, and the two groups showed an almost identical distribution of primary drugs of abuse with the exception of benzodiazepines, which were more common in the AAS group. Because acute influence of certain benzodiazepines, i.e., flunitrazepam has been suggested to trigger violent acts (Daderman et al., 2002), one may suspect that this difference explains some of the violence in the AAS group. However, this notion gained no support from the present study.

The present study seems to add to three earlier studies that have demonstrated a statistically significant increased risk for violent crime in AAS users after controlling for substance abuse (Beaver et al., 2008; Klotz et al., 2007; Petersson, 2008). However, the surprising finding that violent crime was more common in AAS users irrespective of the temporal relationship between the violent crime and AAS use suggests that AASs do not necessarily act as a proximal triggering factor for violent behavior. We can think of two possible explanations for this finding. First, AAS use may be overrepresented in individuals who demonstrate particularly strong risk-taking, impulsive behavior and antisocial lifestyle. Second, AAS use may lead to some long-lasting central effects that lower the threshold for violent behavior or potentiate acute triggers of violence, such as alcohol. Certainly, a combination of these mechanisms should be considered. We believe that future research on AAS-related violence should take other risk factors such as personality traits and acute influence of disinhibiting drugs, as well as possible enduring effects on brain structure and function into consideration.

The finding that 26% of participants had AAS experience corroborates earlier observations that AAS use is relatively common in Swedish criminals with substance abuse (Klotz et al., 2007). It is interesting to note that 5% of female participants reported AAS experience. This proportion is much higher than has been reported in prevalence studies of other populations, which usually are around 0.1% (Bahrke et al., 1998). As far as we know, the motives for AAS use in female criminal substance abusers have not been investigated. The motives for and consequences of AAS use in this particular group are clearly an area of interest.

Benzodiazepines were more often reported as the most frequently used drug during the past year in AAS users, in comparison with non-users. When prescribed, benzodiazepines are used as treatment for anxiety disorders or insomnia. Among substance abusers, it is common to use benzodiazepines to enhance the effect of opiates and to reduce symptoms of alcohol withdrawal (Licata and Rowlett, 2008). However, it is rather rare among substance abusers to use benzodiazepines as a primary drug of abuse, and this

was also the case in our study population. However, even though the proportions of participants citing benzodiazepines as their primary drug of abuse were small, the higher prevalence in the AAS group reached statistical significance. This finding parallels earlier observations of a high prevalence of benzodiazepine use in AAS users at a substance abuse center (Skarberg et al., 2009) and in deceased AAS users of (Petersson et al., 2006b).

4.2. Methodological considerations

The data reported in this study derive from a clinical project that was not initially designed for analyses concerning AAS use and crime. For this reason, many important variables, such as the extent of AAS use and certain risk factors for violent behavior (e.g., acute influence of drugs/alcohol) are lacking. Furthermore, the information is based on self-reporting, which always contributes to a risk of recall bias, and we do not know in what direction a recall bias would affect the result. The original aim of collecting this data was to prevent the transmission of bloodborne pathogens and STDs; therefore, a person with recreational substance abuse who has never injected the substance might have been less inclined to participate, even though the effect of such possible selection bias is unclear.

One strength of the study is the unique large number of participants that report the combination of AAS experience, criminality, and substance abuse. This large number allowed for subdivision with respect to delay between last occasion of AAS use and the criminal act. The study also benefits from the fact that the comparison group turned out to be fairly adequate with respect to pattern of drug use.

5. Conclusion

This study supports the hypothesis that there is a strong connection between AAS and criminality. Furthermore, it suggests that there is a group of female criminals who use AAS. The study also adds to previous studies demonstrating an association between AAS and violent crime in particular; at the same time, the role of AAS as an acute trigger of violence must be questioned on the basis of our findings. In conclusion, the role of AAS in violent crime seems to be complex and should be understood in conjunction with other underlying personal and contextual factors.

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Contributors

Sussi Wallin and Kerstin Käll performed the data collection and contributed to the design of the study. Lena Lundholm and Ingemar Thiblin contributed to the design of the study and performed the analyses. Lena Lundholm wrote the first version of the manuscript. All authors contributed to the final version of the manuscript.

Conflicts of interest

No conflict declared.

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