Anabolic androgenic steroids and violent offending: Confounding by polysubstance abuse among 10,365 general population men

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Abstract

Background and aims: Anabolic androgenic steroid (AAS) use is associated with aggressive and violent behavior, but it remains uncertain if this relationship is causal in humans. We examined the link between AAS use and violent crime while controlling for polysubstance abuse and additional suggested risk factors for violence.

Design: Cross-sectional study of a population-based sample.

Setting: In 2005, all Swedish-born male twins aged 20-47 years were invited to participate in the Swedish Twin Adults: Genes and Environment (STAGE) survey of the Swedish Twin Register (response rate=60%).

Participants: 10,365 male survey participants with information on AAS use.

Measurement: Data on self-reported use of AAS, alcohol and other substances, attention deficit hyperactivity disorder (ADHD) and personality disorder symptoms were linked to nationwide, longitudinal register information on criminal convictions, IQ, psychological functioning and childhood socioeconomic status (SES) covariates.

Findings: Any lifetime use of AAS was strongly associated with conviction for a violent crime (2.7% vs. 0.6% in convicted and non-convicted men, respectively; OR=5.0, 95% CI 2.7-9.3). However, this link was substantially reduced and no longer significant when controlling for other substance abuse (OR=1.6, 95% CI 0.8-3.3). Controlling for IQ, psychological functioning, ADHD, personality disorder symptoms and childhood SES did not reduce the risk further.

Conclusion: In the general population, co-occurring polysubstance abuse, but not IQ, other neuropsychological risks or socioeconomic status, explains most of the relatively strong association between any anabolic androgenic steroid use and conviction for a violent crime.

Introduction

Illicit use of anabolic androgenic steroids (AAS) has primarily aimed at enhancing athletic performance and body appearance. AAS use spread in the general population during the 1980s and is currently seen as a major health problem (1). Beyond desired anabolic muscle building effects, AAS use has been associated with various somatic (e.g., cardiovascular and reproductive) complications, and psychiatric side effects (e.g., depression, irritability, mania) (1-3). AAS are indeed psychoactive substances and affect several neurotransmitters across different brain regions, including the reward system and aggression-related pathways (4), possibly expressed as improved self-esteem but impaired impulse control, extreme mood swings, and aggression (5, 6).

A divergent literature has tested the association of AAS with aggression and violent behavior in humans. For example, Pope et al. (7) studied possible psychiatric effects of supraphysiologic doses of testosterone in normal men. Their randomized controlled trial revealed testosterone-induced mania and verbal hostility responses. However, effects varied considerably across individuals and only a few subjects contributed to the overall weak but significant effect. Klötz et al. (8) examined registered criminality in a selected clinical cohort of individuals tested for AAS use in Sweden. AAS-positive individuals were significantly more often convicted of fraud and weapons offences, but not for violent or property crime. Further, Swedish remand prisoners with known substance abuse reported AAS use more often when suspected of a violent crime as compared to other offence categories. However, no temporal relation to the suspected offence was identified (9). Very few population surveys have addressed a possible AAS-violence link. One nationally representative survey of US adolescents found a small but significant risk for self-reported serious violent behavior among those also reporting AAS use, even after controlling for polysubstance abuse and previous violent behavior (10). Another US population survey suggested that AAS use was strongly associated with self-reported aggressiveness (physical fights, hurting somebody, robbery) (11). To summarize, besides observed aggression and hostility side effects in humans (6, 12) and increased aggressive behavior in male rodents upon chronic AAS exposure (13, 14), results are less consistent among humans and, specifically, the possible causal impact of AAS on interpersonal violence remains unproven.

Recently, AAS use has been identified as one component of polysubstance abuse (1, 15). AAS might be a gateway to other illicit drug use (16) and, conversely, use of illicit drugs might precede that of AAS use (17). A recent Swedish study based on toxicological testing of police suspects found additional licit (e.g., benzodiazepines) or illicit substances in 60% of AAS-positive suspects, with cannabis and amphetamine being the most common (18). Kanayama and Pope concluded that AAS users often engage in experimentation both with additional performance- or appearance-enhancing drugs (e.g., human growth hormone) and classical drugs of abuse (1). Interviews with patients primarily seeking treatment for AAS use indicated polysubstance abuse including amphetamine and ephedrine as attempts to improve endurance and fat burning, cannabis abuse to calm down, and opioids to reduce pain after heavy workout (15). Interviews with substance abusers suggest that most use AAS to improve workout results and get stronger. The few that have other reasons might attempt to conceal concomitant drug use, alleviate self-esteem, or prepare for a crime (19).

The lifetime prevalence of AAS use is much higher in prisoners than general population controls (9, 20), and there are common risk factors for AAS use, criminality and substance abuse in general. Childhood conduct disorder is a major risk factor for AAS use among weight lifters (21) and also substantially increases adult risk for antisocial personality disorder, criminality and overall substance misuse (22, 23).

To conclude, there is indeed an observed *association* between AAS use and violent behavior and AAS use often co-occurs with use of other illicit drugs. However, previous research mainly used small, selected samples that may provide biased estimates of possible causal effects; including weight-lifters (24), substance abusers (19) and remand prisoners (9). Further, the few population- based studies did not focus on the association with violent crime (11, 25) or were limited to adolescents and young adults' self-reported violence (10).

We aimed to expand on previous research by examining the link between AAS use and officially registered violent offending while controlling for polysubstance abuse and additional suggested violence risk factors in one of the largest studies to date, a general population cohort of 20-47 year-old men. Self-reported data on AAS, other drug and alcohol use, ADHD, and personality disorder symptoms were linked to national longitudinal register information on established literature-based violence correlates; general cognitive ability (IQ), psychological functioning and childhood socio-economic status.

Methods

The Swedish Twin Register and STAGE

The Swedish Twin Register encompasses all twins born in Sweden since 1886 (26). In the Study of Twin Adults: Genes and Environments (STAGE), all twins in the Swedish twin register born 1959-1985 (20-47 years at data collection in 2005-2006) and where both siblings were alive and living in the country (n=42,224; 21,174 men, 21,050 women) were invited to participate in a web-based survey. The self-report questionnaire addressed sociodemographic conditions, stressful and traumatic life events, physical and mental health, substance misuse and sexual behavior. Participants could also choose a telephone interview supplemented with a self-administered paper questionnaire for sensitive topics. Non-responders were reminded up to three times and the overall response rate for the survey was 60.1%. Prior linkage with Swedish national registries (27) found that STAGE non-responders do not differ from responders regarding age, birth weight or inpatient treatment for neurological disorders. Nevertheless, non-responders were more often male, criminally convicted, and treated for psychiatric conditions. They were also less educated, and had somewhat lower general cognitive ability (IQ) at mandatory conscription (males only) at age 18 years (all p-values <0.001) (27).

Participants

We included all male STAGE participants who responded to questions on the use of anabolic androgenic steroids (AAS) (n=10,365). Women were excluded due to the rareness of both violent crime (lifetime conviction rate less than 1%) (28) and AAS use (29); of the 4 women reporting AAS use, none was convicted for a violent crime.

Exposure and outcome

Any lifetime use of AAS was examined with the question: *Have you ever used anabolic androgenic steroids?* Violent offending was defined as any conviction of a violent offence in Swedish lower court 1973-2009. The National Criminal Conviction Register includes all persons with custodial or non-custodial sentences; even when a prosecutor decided to caution or fine without a formal trial or a defendant was judged to suffer from medico-legal insanity at the time of perpetration. Since criminal responsibility in Sweden starts at age 15, no

offences committed before this age are recorded in the Conviction Register. In line with previous research, we used a broad definition of violent crime (28, 30) capturing offending with the intention or consequence of causing physical or psychological harm or coercing another individual. We included: homicide, assault, robbery, threats and violence against an officer, gross violation of a person's/woman's integrity, unlawful coercion, unlawful threats, kidnapping, illegal confinement, arson, intimidation, and sexual violence including rape, sexual coercion, and child molestation. Attempted and aggravated forms of these offences were included when applicable.

Potential confounders

Substance abuse

The STAGE self-report provided data on lifetime DSM-IV alcohol abuse/dependence (32) and (lifetime) use of amphetamine, cocaine, cannabis, benzodiazepines or zolpidem, and Rohypnol. Rohypnol use was asked for separately, since its active substance flunitrazepam probably confers a higher risk of dependence and has been claimed to trigger violent behavior (33).

Seven other substances were asked for in the survey and initially tested for their effect on the association between AAS and violence: methylphenidate, codeine, other opioids, ecstasy, LSD, gammahydroxybutyrate (GHB), and psilocybin ("mushrooms"), but not included in our analyses as described under *Statistics.*

For each endorsed substance including AAS, additional questions addressed age at first use, age at most frequent use and intensity during that period, and age at last use. However, substantial non-response rates for these follow-up items would have compromised the analyses and were not used.

General intelligence

General intelligence (IQ) was measured within the Swedish Enlistment Battery, used as part of compulsory conscription, mandatory for more than 95% of young Swedish men up to 2009. The test consists of four subscales capturing different aspects of cognitive ability (verbal, spatial, inductive, and technological), measured on the stanine scale (a normal distribution divided into nine categories, with mean=5 and standard deviation=2). The scale was standardized each conscription year, so there was no change in the distribution over time. A

subset of all men enlisting in 1965 were retested 1-4 years later, yielding high test-retest correlations (1 year and 2 years, respectively=0.89; 3 years=0.80, 4 years=0.84) (34).

Psychological functioning

Psychological functioning was also measured at compulsory conscription. Based on a semi-structured interview by a clinical psychologist, psychological functioning was judged on a 1-9 stanine scale supposedly reflecting stress coping during war or similar extreme stress situations (35).

Attention deficit/hyperactivity disorder (ADHD)

Current ADHD was assessed with the 18 symptom criteria from DSM-IV (32), some slightly rephrased to better suit adults. Respondents self-reported symptoms persisting at least six months on a three-point scale (*0="no", 1="yes, to some extent" or 2="yes.* We constructed a dichotomous measure of possible adult ADHD according to DSM-IV diagnostic cut-offs of six or more out of nine items endorsed with *yes* or *yes to some extent* in the attention deficit and/or the hyperactivity/impulsivity criteria subsets. Age of symptom onset, pervasiveness across settings and distress or impairment criteria were not considered.

Personality disorder

A screen-positive result for self-reported personality disorder was defined as ≥4 points on the eleven-item IOWA Personality Disorder Screen (36). With a ≥4 cut-off, the instrument has a sensitivity of 0.77 and a specificity of 0.71 (37).

Socioeconomic status (SES)

From the National Censuses of 1970, -75, -80, and -85, we obtained socioeconomic characteristics of the early childhood household (childhood family income). For each individual, we used information from the census closest in time to the year after his birth, meaning that age at census ranged from less than 1 to 10 (the latter only for individuals born 1959). Income was based on the taxed income of the "head of household" assigned in the census (in married couples at the time, always the man). To manage skewness and inflation, income was rank coded in deciles (1-10) in each census year. Living with a single mother was coded 1, otherwise 0. We used Statistics Sweden's coding of Household SEI (socioeconomic index) constructed from both parents' occupation and divided into categories reflecting the education needed for the job, associated status and payment. Since SEI coding has changed

somewhat over time, we collapsed the coding into four categories: Low (skilled and unskilled workers across all fields), Medium (low and intermediate position white collar workers), High (high-position white collar workers) and self-employed professionals and entrepreneurs. The latter included all owners of private enterprises (except agricultural), regardless of size (38, 39).

Statistics

The association of lifetime AAS use and violent offending was analyzed with logistic regression and 95% confidence intervals were calculated with robust standard errors (SAS version 9.3) taking the relatedness of twin siblings into account. We adjusted analyses for birth year as a categorical variable and continued with four additional steps. First, birth year-adjusted bivariate associations were calculated separately for AAS, different illicit and licit drugs, and alcohol abuse/dependence with a violent crime conviction as outcome. Second, we tested if including each specific substance individually influenced the association of AAS with violent crime (data not shown). After removing those that did not yield any change in the association of AAS and violent crime (methylphenidate and codeine), we entered all remaining substances (alcohol, amphetamine, cannabis, benzodiazepines, Rohypnol, other opioids, ecstasy, LSD, GHB, and psilocybin)into the model, and proceeded to iteratively remove the substance with the weakest association to violent crime from the model. If removing the substance affected the association (β-value) of AAS with violent crime more than 10% it was reentered into the model, followed by removing the substance with the next weakest association. This variable selection procedure revealed that including any substance in addition to amphetamine and Rohypnol did not further attenuate the association of AAS with violent crime, although several other substances where substantially associated to violent crime (Table 2, third column from the left). However, based on previous research and judging potential loss of power to be minor, we chose to keep four other common drugs of abuse (alcohol, cannabis, other benzodiazepines and cocaine) in the statistical analyses. Third, we performed birth year-adjusted multivariate analyses where use of AAS, Rohypnol, other benzodiazepines, amphetamine, cocaine, cannabis and Alcohol abuse/dependence were entered simultaneously in the model (Table 2, rightmost column). Fourth and finally, we tested the association between AAS and violent crime controlling for the literature-based potential confounders described above. (Table 3).

Missing values for specific covariates were replaced using multiple imputation in fully conditional specification (FCS) (40) models with the SAS command Proc MI. Each covariate was modeled as a function of all other covariates, AAS use and violent crime. Covariates were modeled with ordinal logistic regression, except IQ and psychological functioning which were imputed as linear, bounded by 1 and 9, and rounded to nearest integer. To ensure that the imputation did not unduly influence the results, we present distributions of covariates before and after imputation, and results from complete-case analysis in the appendix (Supplemental tables 1 and 2).

Results

A total of 4.9% of 10,365 male participants (n=511) had been convicted for a violent crime and 0.7% (n=76) reported AAS use. There was no difference in age at first conviction between AAS users and non-users (p>0.80). Table 1 presents distribution and association of self-reported AAS use with other substance use, psychiatric/psychological characteristics and socioeconomic background factors.

Insert table 1 about here

As suggested from Table 2, those convicted of a violent crime more often reported AAS use (2.7% vs. 0.6%, odds ratio [OR] 5.0 (95% CI: 2.7-9.3). This association was substantially attenuated and lost statistical significance after adjusting for other lifetime substance abuse. Similarly, associations decreased considerably also for the five non-AAS lifetime drug abuse practices (Table 2), but less so for DSM-IV Alcohol abuse/dependence when adjusting for co-occurring substance use. However, these links remained significant for any lifetime use of Rohypnol, amphetamine, and cannabis and for DSM-IV Alcohol abuse/dependence. Adjusting only for lifetime use of Rohypnol and amphetamine was sufficient to attenuate the association of AAS with violent crime to a nonsignificant OR of 1.7 (95% CI: 0.9-3.3 (data not shown).

Insert table 2 about here

Table 3 shows the influence of potential confounders beyond co-occurring substance abuse on the association of AAS use and violent offending. Overall, the association between AAS use and violent offending declined (from OR 5.0 to 3.6-4.2) when we adjusted for intelligence, psychological functioning or possible ADHD, respectively. Only marginal changes (to 4.5-4.9) were found for the remaining covariates. Adjusting for all covariates decreased the

association further. Importantly, none of the measured confounders contributed to additional change following adjustment for co-occurring substance abuse. Further, no significant interactions between these covariates and AAS-use on violent crime were found (data not shown).

Insert table 3 about here

Discussion

We conducted, to our knowledge, the first large general population study of the relation between AAS use and violent offending that combined self-reports and registry measures of potential confounders. We found a strong association between self-reported lifetime AAS use and violent offending in a population-based sample of more than 10,000 men aged 20-47 years. However, the association decreased substantially and lost statistical significance after adjusting for other substance abuse. This supports the notion that AAS use in the general population occurs as a component of polysubstance abuse, but argues against its purported role as a primary risk factor for interpersonal violence. Further, adjusting for potential individual-level confounders initially attenuated the association, but did not contribute to any substantial change after controlling for polysubstance abuse.

Overall, the association between each of the six non-AAS types of substance abuse and violence (Table 2) declined after adjusting for other co-occurring substance abuse. Given the imperfect nature of our measures of substance abuse, it is likely that the associations would have been even more attenuated with better measures. At present, associations remained moderately strong (OR $\geq$2.0) and significant for Rohypnol, amphetamine, and DSM-IV Alcohol abuse/dependence in multivariable analyses, indicating unique associations of these substances with violence. A causal relation between alcohol and violence is quite well established (31,41-42). Flunitrazepam became a rather popular drug of abuse in the late 1990s under the brand name Rohypnol and it was suggested that flunitrazepam induced violent behavior (43). Prior case-crossover research from our group suggests that benzodiazepines in regular doses may have a preventive effect on violence risk, while intake of high doses could trigger violent offending (31,44). Amphetamine use, in turn, may have irritability and paranoia as serious side effects that could increase violence risk (45).

We found no additional effect on the association between AAS use and violent offending from self-reported confounders (ADHD and personality disorder symptoms) or register-based covariates (IQ and psychological functioning from military conscription testing, childhood SESc), albeit IQ, personality functioning and ADHD initially attenuated the association. Hence, since prior research posits that these confounders co-vary with substance abuse, it seems that pharmacological, psychological or social effects related to substance abuse *per se* contribute most of the risk for violent offending. This agrees with previous research suggesting a strong relation between substance abuse and violent crime (46). None of the measured covariates exhibited a significant interaction with the AAS-violent crime link. Further, contrary to expected if there was a difference in criminal trajectories between AAS users and non-users; we found no difference in age at first conviction.

The lifetime prevalence of AAS use reported by 20-47-year old men was 0.7%, similar to other population studies (11, 25). This stands in stark contrast to the 20% that had ever used AAS in another contemporary but highly selected Swedish sample of 194 remand prisoners (44). Thus, our data are congruent with the idea that although AAS use is considerably more common among violent offenders, the increased risk of interpersonal violence is conferred by co-occurring abuse of substances such as flunitrazepam, amphetamines, and alcohol. Animal research has also found exacerbated risk for aggressive, competitive and dominance behaviors after intake of alcohol or amphetamine in animals pretreated with AAS (47, 48).

Strengths and limitations

We attempted to elucidate the relationship between an unusual exposure (AAS) and a rare outcome (violent crime) in a large, well-characterized adult population cohort. Since the sample consisted of twins, we had the theoretical possibility to strengthen our study further with complementary co-twin control analyses to handle confounding by factors shared by twins. However, such analyses require twin pairs discordant on the exposure and the rareness of AAS use rendered the statistical power too low for an informative analysis, even in this large sample. Further, unlike previous studies that might have suffered from shared method variance (using self-reported data for both exposure and outcome) we had the opportunity to use an objective outcome measure: conviction of a violent crime.

Some limitations need consideration. First, the STAGE survey had an overall response rate of 60% and as mentioned above, non-respondents were more often male, criminally convicted, treated for psychiatric conditions, less educated, and had lower IQ at conscription (27). Since non-respondents were likely to have higher prevalence of both exposure and outcome variables, this could lead to some underestimation of the true associations of AAS use and other substance abuse with violent offending. Second, self-report data on use of AAS and other substances always involves misclassification risks. If this exposure misclassification was random regarding violent crime, we would underestimate the association of the respective substances and violence. Third, the cross-sectional study design did not allow analysis of the temporal relations of AAS use, other substance use, and violent offending. Thus, conclusions regarding the causal pathways among these variables should be avoided.

Self-reports of ADHD and personality disorder symptoms had many missing values (Supplemental table 2). This resulted primarily from that responders who chose a telephone interview (instead of the web questionnaire) sometimes failed to return the separate, self-administered paper questionnaire with mental health questions. Since it is likely that choice of response format does not occur completely at random, more well-functioning participants probably provided complete data more often. Hence, although we used multiple imputation of data to compensate for this, we could only reduce bias through appropriate confounder control procedures for factors with available data. In other words, estimates for ADHD and personality disorder may have suffered residual selection bias.

Conclusion

Our results suggested that it was not lifetime AAS use *per se*, but rather co-occurring polysubstance abuse that most parsimoniously explains the relatively strong *association* of AAS use and interpersonal violence. Further, substance abuse *as such* might be a more prominent contributor to violence risk than other individual vulnerability; including poorer cognitive ability or psychological functioning, ADHD or personality disorder, or socioeconomic vulnerabilities, although these factors often co-vary with substance misuse. These findings suggest that professional assessment and treatment of violence risk should consider overall substance use patterns rather than AAS use in isolation.

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Table 1. Association of self-reported AAS use with other substance use, psychiatric/psychological and socioeconomic characteristics among 10,365 20-47-year old Swedish general population men.

	Any life-time AAS use		
	No n=10 289	**Yes** n=76	**Univariate analysis**[1] OR (95% CI)
Cocaine	252 (2%)	31 (41%)	25.9 (15.8-42.3)
Amphetamine	425 (4%)	37 (49%)	20.9 (13.2-33.1)
Rohypnol	125 (1%)	19 (25%)	26.0 (14.7-45.9)
Other benzodiazepines	393 (4%)	21 (28%)	10.1 (5.8-17.3)
Cannabis	1979 (19%)	49 (64%)	7.4 (4.5-12.1)
DSM-IV Alcohol abuse/ dependence	1289 (13%)	25 (34%)	3.3 (2.1-5.4)
Methylphenidate	10 (0%)	2 (3%)	40.1 (8.6-187.2)
Codeine	126 (1%)	6 (8%)	7.5 (3.2-17.8)
Morphine	142 (1%)	9 (12%)	9.5 (4.7-19.3)
Ecstasy	207 (2%)	26 (34%)	23.1 (14.0-38.2)
LSD	92 (1%)	11 (14%)	17.3 (9.0-33.5)
GHB	42 (0%)	11 (14%)	35.1 (17.2-71.8)
Mushrooms	147 (1%)	14 (18%)	14.0 (7.6-25.9)
ADHD screening[2]	893 (13%)	15 (29%)	2.8 (1.5-5.1)
IOWA screening for personality disorder[3]	140 (3%)	2 (5%)	1.8 (0.5-7.3)
IQ, m (sd)	5.3 (1.9)	4.4 (1.9)	0.8 (0.7-0.9)
Psychological functioning, m (sd)	5.3 (1.6)	4.6 (2.0)	0.8 (0.6-0.9)
Childhood SES			
Single mother	1792 (17%)	15 (20%)	1.2 (0.6-2.1)
Childhood family income [4]	4.7 (5.0)	4.9 (5.5)	1.0 (0.9-1.2)
Socioeconomic index 1 Low	3665 (38%)	35 (49%)	1.0 (1.0-1.0)
Socioeconomic index 2 Medium	3937 (41%)	22 (31%)	0.6 (0.3-1.0)

Socioeconomic index 3 High	907 (9%)	9 (13%)	0.9 (0.4-1.9)
Socioeconomic index 4 Self-employed	1070 (10%)	5 (7%)	0.5 (0.2-1.3)
Missing data on SEI	710 (5%)	5 (75)	-

Notes:

[1]Birth-year adjusted 95% confidence intervals based on robust standard errors accounting for relatedness between twin siblings.
[2]Proportions based on number of responders with ADHD-screening (n= 6867).
[3]Proportions based on number of responders with personality disorder symptom -screening (n= 5257).
[4]Income was based on the taxed income of the "head of household" assigned in the census (in married couples at the time, always the man). To manage skewness and inflation, income was rank coded in deciles (1-10) in each census year.

Table 2. Self-reported lifetime substance use and risk of any violent crime conviction among 10,365 20-47-year old men in the Swedish general population.

	Violent offending			
Substance	**Yes (n=511)**	**No (n=9854)**	**Bivariate Odds Ratio[a]**	**Multivariable Odds Ratio[b]**
AAS	14 (2.7%)	62 (0.6%)	5.0 (2.7-9.3)	1.6 (0.8-3.3)
Rohypnol	40 (7.8%)	104 (1.1%)	9.0 (6.0-13.7)	2.1 (1.2-3.7)
Other benzodiazepines	56 (11.0%)	358 (3.6%)	3.3 (2.4-4.5)	1.1 (0.7-1.6)
Amphetamine	97 (19.0%)	365 (3.7%)	6.9 (5.3-8.9)	2.7 (1.9-4.0)
Cocaine	55 (10.8%)	228 (2.3%)	5.8 (4.2-8.0)	0.9 (0.6-1.5)
Cannabis	208 (40.1%)	1820 (18.5%)	3.2 (3.1-4.6)	1.8 (1.5-2.3)
DSM-IV Alcohol abuse/ dependence[c]	159 (32.1%)	1155 (12.0%)	3.8 (3.1-4.6)	2.7 (2.2-3.4)

Notes:

Numbers in parentheses in the two rightmost columns are 95% confidence intervals based on robust standard errors accounting for relatedness between twin siblings.

a) Adjusted only for birth year.

b) Adjusted for birth year and co-occurring lifetime use of the other five tested substances or Alcohol abuse/dependence.

c) A total of 261 individuals lacked information needed to diagnose Alcohol abuse/dependence.

Table 3. Influence of potential confounders on the association between any lifetime AAS use and a violent crime conviction among 10,365 20-47-year-old men in the Swedish general population.

Covariate	**Association between AAS use and violent crime, adjusted for:**	
	Birth year and specific covariate[a]	**Birth year, co-occurring substance abuse and specific covariate[a]**
General intelligence (IQ)	4.0 (2.1-7.5)	1.3 (0.6-2.7)
Psychological functioning	3.6 (1.8-7.0)	1.4 (0.7-3.0)
DSM-IV ADHD	4.2 (2.3-7.8)	1.4 (0.7-2.8)
Possible personality disorder (IOWA)	4.5 (2.4-8.5)	1.5 (0.7-3.1)
Childhood family income	4.9 (2.7-9.0)	1.5 (0.7-3.1)
Childhood SEI	4.6 (2.4-8.6)	1.5 (0.7-3.0)
Single mother family during childhood	4.8 (2.7-8.8)	1.5 (0.7-3.0)
All covariates	3.1 (1.6-6.2)	1.3 (0.6-2.9)

Notes:

Associations are expressed as odds ratios; figures within parentheses are 95% confidence intervals based on robust standard errors accounting for relatedness between twin siblings.

a) Indicates specific covariate at the beginning of each row, respectively.