

Anabolic Androgenic Steroids in the General Population: User Characteristics and Associations with Substance Use

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Key Words

Anabolic androgenic steroids • Substance use disorders • Drug addiction

Abstract

Aims: To analyse correlates of anabolic androgenic steroids (AAS) use in the general male population. **Design:** A national household survey. **Participants:** Individuals aged 15–64 years in Sweden. **Measurements:** AAS use and potential correlates of AAS use, including demographic data, financial situation, physical training, and substance use. In hierarchical logistic regression analyses, lifetime users of AAS ($n = 240$) were compared to all nonusers ($n = 13,920$) and to nonusers who reported that they had been offered AAS ($n = 487$). **Results:** AAS use was most strongly associated with a lifetime history of illicit drug use and the misuse of prescription drugs. When controlling for substance use, AAS was associated with physical training and lower education. Illicit drug use and misuse of prescription drugs separated AAS users from nonusers who had been offered AAS. No associations were seen with AUDIT scores for risk alcohol drinking. **Conclusions:** In this general population survey in men, lifetime use of AAS appears to share common characteristics

with illicit substance use. Both substance use variables and physical training remained associated with AAS use when controlling for one another. Copyright © 2012 S. Karger AG, Basel

Introduction

The use of anabolic androgenic steroids (AAS) for performance-enhancing purposes among athletes has been reported since the 1950s [1], whereas in the 1980s, the first reports revealed that AAS had gained popularity among young males for purposes related to muscle size and physical appearance [2, 3]. The use of AAS has been associated with severe medical consequences, including cardiovascular complications [4], endocrine complications, and psychiatric complications such as depressed mood and a possible link to violent behavior [1, 5]. In literature focusing on the purposes of AAS use, data show that apart from the performance-enhancing use of bodybuilders and other athletes, many AAS users report a desire to improve their physical appearance or to strengthen their self-esteem [2, 6, 7].

Several studies have described the characteristics of AAS users. However, while few surveys have been performed in the general population, there are several surveys conducted in specific subgroups with elevated risk of AAS use [8], such as adolescents [9–16], criminal justice clients [17–19], health club attendees [20], or clients in substance abuse treatment [7, 21]. The paper by Yesalis et al. [22], from the US National Household Survey on Drug Abuse, is among the very few papers assessing the prevalence or correlates of AAS in the general population, without restricting the study population to younger subjects or other risk groups. Another population study is the work by Rachón et al. [23], who studied a survey conducted through internet sites in Poland, with participants from broader age groups with a mean age of 23 years.

The US national household survey [22] reported that estimates of lifetime prevalence of AAS use were 0.9% for males and 0.1% for females in the general population. In younger subjects, higher estimates have been reported, generally ranging between 1.5 and 6% of young males, and consistently with lower prevalence rates in young females, ranging between 0 and 2.4% [8, 12, 13, 16, 24–26]. The internet survey in Poland reported by Rachón et al. [23] displayed somewhat higher figures compared to most studies (6% in males and 3% in females).

A link between AAS use and other substance use has been demonstrated in several studies in different settings, including the younger age groups of the US general population [22], high school students, college students and adolescents [9, 11–14, 16, 24, 25, 27], criminals [17], and in treated AAS users [21]. Other possible correlates of AAS use may be negative school experiences, lower level of education, a disadvantageous childhood, and a more unstable current social situation [28]. Also, a link between AAS use and criminal behavior has been described [29]. Intuitively, while the use of AAS appears to be more likely to occur in some risk groups and settings, it is relevant to examine individuals who have been offered to use AAS without actually using, and how users differ from these nonusers. This has been studied in one paper in the international literature [15], demonstrating that subject who reported actually using AAS were more likely to report cannabis use.

Thus, while the correlates of AAS use have been examined in specific risk groups such as adolescents, a significant proportion of lifetime AAS users are above their age [22, 23], and there is relatively little knowledge about the clinical correlates of AAS use in the general population. Therefore, the present study aims to analyse possible correlates of AAS use in the general population, compared

to all nonusers and to nonusers who have been offered AAS, and to study, in a multivariate model, the associations of potential risk factors such as substance use, level of education, socioeconomic status and physical training, when controlling for one another.

Materials and Methods

The present analysis is based on a national household survey assessing the extent and characteristics of drug use in the Swedish general population. Between November 2008 and February 2009, the Swedish National Institute of Public Health, and Clinical Alcohol Research, Lund University, performed a national household survey addressing a sample of 58,000 individuals, as a part of the so-called ‘prevalence project’, a larger project aiming to describe illicit drug use in the population. From the Swedish general population of individuals aged between 15 and 64 years, a sample of 58,000 individuals was randomly selected, although with an oversampling of groups suspected of being at higher risk of drug use and higher risk of a low response rate (male gender, younger age, lower level of education and larger town of residence), in order to allow for a more extensive dataset of subjects with a history of illicit drug use [30].

The survey was sent by mail, and could be answered either by mail or on the internet. The survey was sent along with an information letter and an envelope for the return of the survey. Reminders were sent after two weeks and, again, after four weeks. Statistics Sweden, the national agency for population statistics, performed the statistical design of the survey, and also completed survey data with register data regarding a number of demographic variables.

A total of 22,095 subjects (38%) completed the survey, 81% of them by mail and the remaining 19% on the internet. In order to analyse how responders may have differed from nonresponders, a sample of 1,000 nonresponders were contacted by telephone, and 53% of them were successfully reached for a shorter version of the original survey and compared to the data from the original respondents in a secondary analysis. From this analysis, it was reported that no significant differences in drug use variables were seen between original responders and telephone responders. The weighted response rate of the present survey was 52% [30], indicating that nonresponders were more likely to belong to the over-sampled groups.

As part of the larger project, prevalence of substance use in the general population was calculated, and reported by the Swedish National Institute of Public Health in a report published online [30]. In the calculations of prevalence figures, data were weighted, consistent with the oversamplings carried out in the sample addressed. After this, the data material was further assessed by the present research group at Lund University, Malmö, Sweden. Here, in the calculation of statistical associations rather than prevalence rates, unweighted data are used.

The whole project was assessed and approved by the Ethics Committee of Lund University, Sweden.

In a section addressing other drug use than alcohol, three questions in the survey assessed substances used for physical enhancement. The first two questions were ‘Have you ever taken a

substance with the purpose of increasing your physical capacities?' and 'Has this substance been a dietary supplement?', and the third question, used in the present analyses, was 'Have you ever used anabolic steroids?'. The possible answers to the latter question were 'No', 'No, but have been offered to use', 'Yes, but more than 12 months ago', 'Yes, during the past 12 months', and 'Yes, during the past month'. In the first analysis, we dichotomized the data into a variable describing lifetime use of AAS versus no use, and in the second analysis, we used a dichotomous variables describing lifetime history of AAS use versus individuals who answered that they had been offered but had not used AAS.

As independent variables examined for their possible association with AAS use, the following variables were included: age (classified in 5-year categories, 15–19, 20–24 years, etc.), country of birth (born in Sweden or not), level of education (education above high school level or not), income (above median or not), marital status (married/living with one's partner versus other marital status), regular physical training (regular training at a gym or other training facility), financial problems (repeated difficulties paying for food, housing etc during the past year), bad general health (defined as stages three to five on a Likert scale ranging from 'very good' to 'very bad'), current tobacco smoking (yes or no), lifetime history of misuse of prescribed tranquillizers, sleeping pills or analgesics (yes or no), and lifetime history of illicit substance use (use of any vs. none of the included substances; cannabis, amphetamine, cocaine, opiates, ecstasy, hallucinogenic drugs). For substance use, it was stated in the questionnaire that only misuse without a doctor's prescription was to be reported. In addition, current risk alcohol drinking was assessed with the Alcohol Use Disorder Identification Test, AUDIT [31]. Consistent with previous data and the cut-off level usually applied in men [32], we defined risk drinking as an AUDIT score of eight or above. Thus, subjects were considered not to be risk drinkers if their AUDIT scores were below eight, or if they reported to be never-drinkers (subjects who answered, in the first AUDIT item, that they never drink, were told to leave out the remaining AUDIT items in the questionnaire).

Subjects who failed to answer the question about AAS experience (3.5% of males, 575 subjects, and 4.0% of females, 293) were excluded. Thus, a total number of 14,160 males and 7,051 females were further assessed. Due to the low number of females reporting AAS use, the further statistical analysis is based on the male respondents only.

Statistical Methods

The analysis was performed as a hierarchical logistic regression analysis, with AAS use as the dichotomized dependent variable (in the first analysis, AAS users vs. all nonusers, and, in the second analysis, AAS users vs. nonusers who had been offered AAS). All statistical analyses were conducted in the software SPSS version 17.0.

In the first logistic regression model, background factors were entered as independent variables (age, country of birth, level of education, income and marital status). In the second model, in addition, regular physical training was entered. In the third model, in addition, variables describing substance use and current situation were entered (financial problems, bad general health, smoking, risk drinking, prescribed drug misuse and illicit drug use). The odds ratios in association with AAS use were reported with a 95% CI. The explanatory value of each model for the dif-

ference between AAS users and nonusers was described using Nagelkerke's R^2 [33].

Logistic regression analyses excluded clients for whom data were missing in any one of the variables entered into the model. Thus, the number of male individuals assessed in each model was 13,985, 13,854, and 12,844, respectively, in the first analysis. Variables which contained missing data in the whole dataset of included subjects were country of birth ($n = 71$), level of education ($n = 135$), regular physical training ($n = 138$), financial problems ($n = 379$), general health ($n = 57$), current smoking ($n = 83$), risk drinking ($n = 365$), misuse of prescription drugs ($n = 270$) and illicit drugs ($n = 196$). In the second analysis, the numbers of subjects included in each model were 722, 716, and 679, respectively.

Results

Any history of AAS use was reported by 240 males (1.7% of unweighted data, 0.7% of weighted data) and 18 females (0.3% unweighted, 0.002% weighted) in the present sample. Another 487 males (3.4% unweighted, 1.9% weighted) and 47 females (0.7% unweighted, 0.2% weighted) reported that they had ever been offered AAS substances but without using. In the sample of male respondents, who were included in the further analysis, the mean age (unweighted) was 29.0 years (39.8 years weighted). Calculated as weighted numbers, 46% of the population of users were 30 years or older, and 35% were 40 years or older. 42% (unweighted, $n = 5,907$) were married or living with their partner (61% weighted), and 92% (unweighted, $n = 12,969$) were born in Sweden (83%, weighted). 41% (unweighted, $n = 5,782$) reported at least some higher education (31%, weighted). 29% (unweighted, $n = 4,128$, 22% weighted) were risk drinkers with an AUDIT score of eight or more. 15% (unweighted, $n = 2,065$, 11% weighted) reported a lifetime history of misusing tranquillizers, sleeping pills or analgesics, and 31% (unweighted, $n = 4,426$, 22% weighted) reported a history of illicit substance use (table 1).

In the hierarchical logistic regression analysis, in the first model, describing demographic background data, lifetime history of AAS use was significantly associated with older age, and negatively associated with higher education. In the second model, regular training was significantly associated with AAS use, while the associations with age and education remained. In the third model, where information about current situation and substance use was included into the model, the association with older age disappeared, while AAS use remained negatively associated with higher education. Here, the association with physical training was strengthened, and a higher income became significant-

Table 1. Frequencies of independent variables in AAS users, in nonusers who have been offered AAS, and in all nonusers (weighted data)

| | AAS users | Nonusers, offered AAS | All nonusers |
|--|-----------|-----------------------|--------------|
| Mean age, years | 34.6 | 31.8 | 40.1 |
| Born in Sweden | 97% | 97% | 83% |
| Higher education | 8% | 34% | 33% |
| Income above median | 14% | 55% | 58% |
| Married or living with partner | 15% | 50% | 61% |
| Physical training | | | |
| Regular gym or other physical training | 41% | 13% | 22% |
| Current situation and substance use | | | |
| Financial problems past year | 50% | 20% | 10% |
| Bad general health | 7% | 38% | 21% |
| Tobacco smoking | 9% | 19% | 10% |
| Alcohol risk consumption | 45% | 47% | 23% |
| Misuse of prescription drugs, ever | 49% | 28% | 11% |
| Illicit substance use, ever | 66% | 49% | 23% |

Table 2. Variables associated with a lifetime history of AAS use in males

| Independent variables | Model 1 OR (95% CI) | Model 2 OR (95% CI) | Model 3 OR (95% CI) |
|---|------------------------|------------------------|------------------------|
| Background data | | | |
| Age (5-year interval) | 1.21 (1.13–1.30) | 1.25 (1.16–1.34) | 1.08 (0.99–1.18) |
| Born in Sweden | 1.24 (0.75–2.07) | 1.38 (0.80–2.37) | 1.13 (0.63–2.00) |
| Higher education | 0.41 (0.30–0.55) | 0.39 (0.29–0.53) | 0.40 (0.29–0.55) |
| Income above median | 0.90 (0.66–1.21) | 0.86 (0.64–1.17) | 1.41 (1.02–1.93) |
| Married or living with partner | 1.21 (0.91–1.61) | 1.25 (0.94–1.66) | 1.23 (0.92–1.65) |
| Physical training | | | |
| Regular gym or other physical training | | 1.53 (1.17–2.01) | 1.73 (1.29–2.32) |
| Current situation and substance use | | | |
| Financial problems past year | | | 1.80 (1.28–2.53) |
| Bad general health | | | 1.11 (0.77–1.61) |
| Tobacco smoking | | | 1.59 (1.12–2.27) |
| Alcohol risk consumption | | | 1.16 (0.87–1.54) |
| Misuse of prescription drugs, ever | | | 4.66 (3.44–6.31) |
| Illicit substance use, ever | | | 4.53 (3.15–6.50) |
| Clients included in regression analysis | 13,985 | 13,854 | 12,844 |
| Nagelkerke's R ² | 0.03 | 0.03 | 0.21 |

Hierarchical logistic regression analysis (unweighted data).

ly associated with a history of AAS use. Also, AAS use was significantly associated with recent financial problems, current tobacco smoking, and more strongly with use of illicit drugs and misuse of prescription drugs. No association was seen between AAS use and risk alcohol drinking or general health. Nagelkerke's R² for the first,

second and third models was 0.03, 0.03 and 0.21, respectively (table 2).

In the subgroup of subjects reporting they had ever been offered AAS, in the final logistic regression model, the actual use of AAS was associated with the misuse of prescription drugs, illicit drugs and with tobacco smok-

Table 3. Variables associated with a lifetime history of AAS use among males reporting a history of being offered to use AAS

| Independent variables | Model 1 OR (95% CI) | Model 2 OR (95% CI) | Model 3 OR (95% CI) |
|---|------------------------|------------------------|------------------------|
| Background data | | | |
| Age (5-year interval) | 1.41 (1.26–1.58) | 1.41 (1.25–1.58) | 1.38 (1.20–1.57) |
| Born in Sweden | 1.24 (0.68–2.26) | 1.41 (0.75–2.65) | 1.25 (0.61–2.54) |
| Higher education | 0.69 (0.48–0.995) | 0.71 (0.49–1.02) | 0.79 (0.53–1.18) |
| Income above median | 0.91 (0.64–1.31) | 0.93 (0.65–1.33) | 1.33 (0.88–2.01) |
| Married or living with partner | 1.12 (0.80–1.57) | 1.14 (0.81–1.59) | 1.33 (0.92–1.92) |
| Physical training | | | |
| Regular gym or other physical training | | 0.97 (0.70–1.36) | 1.21 (0.83–1.76) |
| Current situation and substance use | | | |
| Financial problems past year | | | 1.30 (0.83–2.03) |
| Bad general health | | | 1.12 (0.69–1.82) |
| Tobacco smoking | | | 1.59 (1.00–2.51) |
| Alcohol risk consumption | | | 0.99 (0.68–1.44) |
| Misuse of prescription drugs, ever | | | 2.28 (1.56–3.34) |
| Illicit substance use, ever | | | 2.03 (1.31–3.14) |
| Clients included in regression analysis | 722 | 716 | 679 |
| Nagelkerke's R ² | 0.08 | 0.08 | 0.21 |

Hierarchical logistic regression analysis (unweighted data).

ing. In all three models, AAS use was associated with older age, whereas no association was seen with other variables (table 3).

Discussion

The present study is one of the few studies analyzing risk factors of AAS use among men in a general population survey, and here, in this broader population survey, we included several potential risk factors of AAS use identified in other studies performed in adolescents, young adults or other subgroups at particularly high risk of AAS use. Also, the present study is the first to report data from the general male population regarding how AAS users differ from nonusers who report that they have been offered to use AAS. As in many previous studies [34], prevalence figures among women are very low, and the statistical analysis of the present paper is therefore restricted to the male population.

The mean age (weighted) of males with previous AAS use was 35 years, and according to the weighted data, 46% of users were 30 years or older, including 35% of the population who were 40 years or older. General population surveys are few [22, 23], and many studies instead have

been conducted among adolescents. The data published by Yesalis et al. [22] demonstrated that half of AAS users were older than 26 years of age. However, subjects in other risk groups such as athletes or criminals may often be older [17, 20, 28], and since the use of AAS in nonathletes has been a problem since the 1980s, lifetime history of AAS is now also reported among adults. This group of older men who report lifetime use of AAS is likely to differ from younger users, and weighted data on AAS users here showed that users of illicit drugs were younger, and clients reporting misuse of prescription drugs were older (data not shown), but such estimates on a small number of AAS users must be interpreted with great caution, and go beyond the scope of the present study.

Several previous studies have documented an association between AAS use and other substance use, lower level of education, and physical exercise, but mainly in risk groups, including adolescents. In the present analysis in the general male population, where older subjects were also assessed, the same associations were seen. The association between AAS use and the misuse of prescription drugs [12] or illicit drugs is consistent with previous findings in the general US population [22], and in different subgroups such as among adolescents [9, 13, 14]. Also, in weight lifters, AAS dependence has been reported to be

associated with opioid use disorders [35], and a link between AAS and opioid abuse has been supported by observations in animals and humans [36]. Here, the third model in the hierarchical logistic regression analysis had a markedly larger explanatory value vis-à-vis the differences between AAS users and nonusers, than background data and physical training. The present findings demonstrate that male users of AAS may share similar characteristics with individuals who use illicit drugs or who misuse sedatives or analgesics.

On the other hand, risk drinking was not related to AAS use in the present survey. Although weighted prevalence data should be interpreted with caution, the proportion of risk drinkers was high among AAS users compared to previous population data from the Swedish male general population [37]. The proportion of risk drinkers was also higher than among nonusers, whereas no statistical association was seen between risk drinking and AAS use with illicit drugs and prescription drugs included in the model. Previously, an association has been described between alcohol use and AAS in adolescent samples [9, 11, 13, 14], and in the general population [22]. In the present study, the time frame considered was different for AAS use (lifetime) and alcohol use, as most items in the instrument chosen measure the present or the past 12 months. It can not be excluded that an association would have been seen if a lifetime measure of risky alcohol behavior would have been used.

Interestingly, when analyzing only individuals who had been offered to use or who actually used AAS, drug-related variables were the only variables associated with the actual use of AAS. The present paper is, to the best of the authors' knowledge, the first paper to assess differences in the broader general male population of AAS users compared to individuals who report being offered but who deny the use of AAS. Here, no association was seen with physical training. This may indicate that involvement in sports or other physical training is crucial in many cases for an individual to get into contact with AAS use. Also, the association with substance use variables here may indicate that regardless of setting and whether the individual is regularly training or not, males who are more likely to use drugs in their lifetime are also more likely to be those who actually use AAS when it is offered. This finding is consistent with the data reported by Wichström and Pedersen [15], where cannabis use was more common among AAS users than among nonusers who had been offered AAS.

The present study does not permit conclusions to be drawn about the temporality of AAS and other substance use. The results demonstrate a relatively strong association between AAS use and illicit drug use or misuse of

prescription drugs, whereas substance use may have occurred before or after the use of AAS. A gateway hypothesis has been discussed in the literature, meaning that the use of AAS may increase the risk of subsequent illicit drug use [38], although there is also data showing that in many individuals with both types of substance use, the use of illicit drugs preceded the use of AAS [17]. Although temporality can not be thoroughly analyzed from the present study, where first-time use was not assessed, we conclude that AAS use and illicit substance use had a relatively strong correlation in this male general population study, and regardless of whether illicit drugs use or AAS occurred first, these variables appear to be associated and may share common characteristics.

Importantly, the association with AAS use was seen both for regular physical training and substance use variables, when controlling for one another. The association with physical training is consistent with previous literature in other studies [9, 23] and not surprising. Here, this association was even strengthened when substance use variables were included in the analysis. Although the association between the use of AAS and other drugs was strong, involvement in physical training in males appears to have an independent association with AAS use, independent of substance use variables.

The negative association between AAS use and higher education is consistent with previous data [28]. Here, this association remained stable throughout the hierarchical regression analysis, also when physical training and substance use variables were included in the model. Also, the analysis demonstrated an association of AAS use with past-year financial problems, which may be seen as an expected finding, considering previous data on socioeconomic and educational problems among AAS users [28]. Having an income above the median was unrelated to AAS use in the first two models of the analysis, but became positively associated, although marginally, only when financial problems were entered in the model, and the descriptive analysis even indicated a lower income level in AAS users. Thus, the slight positive association with higher income in the final model should be interpreted only in relation to the association between AAS use and financial troubles.

Limitations

The response rate of the present population survey (38%, a weighted response rate of 52%) is a limitation. The comparison with nonresponders reached on telephone,

however, did not reveal significant differences in drug use between responders and nonresponders, although it cannot be ruled out, that nonresponders who were also not reached for the telephone survey, may differ from other subjects.

In order to identify a larger number of substance users, the survey addressed an oversampling of risk groups with higher likelihood of drug use. Thus, the present unweighted data cannot readily be used for estimations of prevalence, whereas in the present study, we have used the data for calculations of statistical associations. Another limitation is that while AAS use is known to be related to criminal behavior [29], the present survey did not contain a variable describing general criminal involvement. Thus, while several other known or potential risk factors could be studied also in this general population survey, criminal involvement was not one of those.

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Conclusions

Consistent with previous data from known risk groups, the present survey in a general male population demonstrated a pronounced association between AAS use and other illicit drug use and misuse of prescription drugs. Both substance use variables, physical training and level of education remained associated with AAS use also when controlling for one another. Also, substance use variables also separated AAS users from nonusers who had been offered AAS without using.

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