# Psychological and Physical Impact of Anabolic-Androgenic Steroid Dependence

**Article** *in* Pharmacotherapy · October 2012

DOI: 10.1002/j.1875-9114.2012.01123 · Source: PubMed



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# Psychological and Physical Impact of Anabolic-Androgenic Steroid Dependence

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**Study Objective.** To contrast the characteristics of two groups of anabolic-androgenic steroid (AAS) users—those with versus those without AAS dependence.

**Design.** Subanalysis of data from the Anabolic 500, a cross-sectional survey.

**Participants.** One hundred twelve male AAS-dependent users and 367 AAS-nondependent users who completed an online survey between February 19 and June 30, 2009.

**Measurements and Main Results.** Respondents were recruited from the Internet discussion boards of 38 fitness, bodybuilding, weightlifting, and steroid Web sites. The respondents provided online informed consent and completed the Anabolic 500, a 99-item Web-based survey. Self-reported data included demographics, exercise patterns, use of AAS and other performance-enhancing agents, adverse effects of AAS use, behavior consistent with *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision* (DSM-IV-TR) criteria for AAS dependence, history of illicit drug and alcohol use, history of sexual or physical abuse, and psychiatric conditions diagnosed according to the DSM-IV-TR. Behavior consistent with AAS dependence was identified in 23.4% of the survey participants. These AAS-dependent users were more excessive in their AAS use (e.g., higher doses, higher quantity of agents, longer duration of use), more likely to report a history of illicit heroin use in the last 12 months (5.4% vs 1.9%, p=0.049), and more likely to report a diagnosis of an anxiety disorder (16.1 vs 8.4%, p=0.020) or major depressive disorder (15.2% vs 7.4%, p=0.012) than AAS-nondependent users.

**Conclusion.** Data from the Anabolic 500 survey showed that almost one quarter of AAS users were dependent on these drugs. These AAS-dependent users had a higher rate of heroin use as well as anxiety and major depressive disorders compared with AAS-nondependent users. These findings can help clinicians and researchers better understand and address the potential illicit drug use and psychiatric comorbidities that may be present among AAS-dependent users.

**Key Words:** anabolic steroids, anabolic-androgenic steroids, AAS, abuse, dependence.

**(Pharmacotherapy 2012;32(10):910–919)**

Anabolic-androgenic steroids (AAS) are a class of drugs that include the male sex hormone testosterone and its synthetic derivatives.[1] Misuse of AAS by athletes and other individuals who participate in strength training has been reported in the literature for decades[2, 3]; however, it was

not until the 1980s that case reports began describing individuals displaying an apparent dependence on AAS.[4] Over the years, AAS dependence has been identified through various versions of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM)'s criteria for substance dependence (DSM-III-Revised, DSM-IV, and DSM-IV–Text Revision [TR]).[5–7] Recently, more AAS-specific diagnostic criteria for classifying AAS dependence were proposed,[8] which were then validated.[9] Using these more specific diagnostic methods, roughly 30% of AAS users have been classified as AAS dependent.[4, 10–18]

Although studies have been successful in identifying AAS-dependent individuals, limited information has focused on the demographic and clinical characteristics of the AAS-dependent user. In addition, sample sizes in previous comparison studies have been relatively small.[4, 10–12] One study of 28 AAS-dependent and 21 AAS-nondependent users showed that the AAS-dependent subjects had a greater number of AAS cycles, used higher doses, were more likely to "not feel big enough" after AAS use, and had a higher number of aggressive symptoms than AAS-nondependent users.[10] Similarly, in another study, 12 AAS-dependent users incorporated a greater number of AAS cycles and had a higher AAS "on cycle:off cycle" ratio than nine nondependent users.[12] A third study of 23 AAS-dependent and 77 AAS-nondependent users demonstrated that participants with AAS dependence or abuse were 4 times as likely to experience "roid rage" than AAS-nondependent users.[4] The group of investigators who proposed the more specific AAS dependence classification criteria[8] performed an extensive study using these criteria in AAS-dependent individuals.[11] They assessed the characteristics of 20 AAS-dependent users, 52 AAS-nondependent users, and 72 nonusers and found that AAS-dependent individuals had a greater incidence of conduct disorder, any substance dependence (not including alcohol), cocaine dependence, and opioid dependence or abuse than AAS-nondependent users.[11]

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For reprints, visit http://caesar.sheridan.com/reprints/redir.php?pub = 10089&acro=PHAR. For questions or comments, contact Eric J. Ip, Pharm.D., BCPS, CSCS, C.D.E., Touro University California College of Pharmacy, 1310 Club Drive, Vallejo, CA 94592; e-mail: eric.ip@tu.edu.

Despite the available data regarding AAS dependence, a larger-scale study contrasting AAS-dependent users with AAS-nondependent users would substantially add to the body of knowledge in this area. Thus, the purpose of our study was to contrast the patient characteristics of male AAS-dependent and AAS-nondependent users. To our knowledge, this study represents the largest comparison of these groups.

## Methods

### Study Design and Patient Population

A 99-item Internet-based survey, the Anabolic 500, was administered through SurveyMonkey (Palo Alto, CA) to assess characteristics of men who participated in strength training.[18] In this subanalysis of the survey data, AAS-dependent users were contrasted with nondependent users. The following self-reported variables were assessed: demographics, exercise patterns, AAS and other performance-enhancing agent use, adverse effects of AAS use, history of illicit drug and alcohol use, behavior consistent with DSM-IV-TR criteria for AAS dependence, DSM-IV-TR psychiatric conditions diagnosed by a health care professional (participants were presented with a series of "yes/no" options for a list of DSM disorders), and history of sexual or physical abuse.

Men were eligible to participate in the survey if they had Internet access, regularly participated in strength-training exercise, and reported a history of AAS use. For this subanalysis, data from AAS users were included only if they completed the DSM-IV-TR–adapted questionnaire for AAS dependence.[4, 15, 18] Details of the questionnaire are shown in Table 1. Individuals who reported three or more symptoms on the questionnaire met the criteria for behaviors consistent with AAS dependence and were placed into the AAS-dependent user cohort. Those with fewer than three symptoms were classified as AAS-nondependent users and were placed into the second cohort. Data from prematurely closed or incomplete surveys (i.e., not reaching the end of the survey), surveys with hoax or illogical responses, and surveys filled out too rapidly (< 5 min for a self-reported AAS user) were excluded from the study. Any survey responses by women were also excluded from the current analysis. A pilot test of 15 weightlifters demonstrated that the average AAS user spent roughly 30 minutes to complete the survey.

**Table 1. Self-Reported Symptoms of Substance Dependence Described by the Anabolic-Androgenic Steroid Users**

| Criteria for Dependence | AAS-Dependent Users[a] (n=112) | AAS-Nondependent Users (n=367) | p Value |
|---|---|---|---|
| Decreased effect over time with the same dose of the substance | 81 (72.3) | 60 (16.4) | <0.001 |
| A need to use increased amount of the substance to achieve the desired effect | 79 (70.5) | 63 (17.2) | <0.001 |
| Physical or emotional problems when substance is stopped | 65 (58.0) | 42 (11.4) | <0.001 |
| Taking larger amounts of the substance over a longer period of time than originally intended | 65 (58.0) | 28 (7.6) | <0.001 |
| Spending a great deal of time in activities related to obtaining the substance | 45 (40.2) | 37 (10.1) | <0.001 |
| Restarting the substance to relieve problems or symptoms that occurred when you stopped | 42 (37.5) | 13 (3.5) | <0.001 |
| Quitting or reducing social, occupational, or recreational activities because of substance use | 35 (31.3) | 17 (4.6) | <0.001 |
| Continued use of substance despite experiencing physical, emotional, or social problems caused by substance | 40 (35.7) | 7 (1.9) | <0.001 |
| Having the desire to or making unsuccessful efforts to decrease the amount of substance taken | 15 (13.4) | 4 (1.1) | <0.001 |

Data are no. (%) of survey respondents.
AAS = anabolic-androgenic steroids.
[a]All 112 participants in this cohort reported $\geq$ 3 of these symptoms and thus met the criteria for behaviors consistent with AAS dependence ($p<0.001$ vs AAS-nondependent user cohort).

### Data Collection and Data Security

Participants were recruited from 38 Internet discussion boards of fitness, bodybuilding, weightlifting, and anabolic steroid Web sites between February 19 and June 30, 2009. Strategies to enhance visibility and survey participation on discussion boards were adopted.[19] A survey Web link directed potential participants to an informed consent page that described the study in detail as well as any procedures used to safeguard confidentiality and anonymity. After reading a complete description of the study, informed consent was obtained. Individually identifiable data were not collected, Internet provider addresses were not logged, and data transfer was encrypted. Only researchers identified in the institutional review board proposal had access to the data, and all researchers had previously completed a National Institutes of Health human subjects training program. The study received institutional review board approval from Touro University.

### Statistical Analysis

Statistical analyses were conducted using STATA 10.0 (StataCorp LP, College Station, TX). Categoric data are reported as numbers and percentages of respondents, and continuous data are reported as mean ± SD. Bivariate statistics were used to determine the association between variables. The Fisher exact test and $\chi^2$ test were used to determine statistical significance for categoric variables; Student *t* tests were used for continuous variables. A p value of less than 0.05 was considered to indicate a statistically significant difference.

As mutually exclusive cohorts are necessary for statistical comparisons, each participant was assigned to one of two groups: AAS-dependent users or AAS-nondependent users. Bivariate statistics were calculated to assess the association between AAS dependent status and participants' demographic characteristics, reported AAS and other performance-enhancing agent use, adverse effects of AAS use, history of illicit drug and alcohol use, DSM-IV-TR psychiatric conditions diagnosed by a health care professional, and history of sexual or physical abuse.

## Results

When the survey closed on June 30, 2009, there were 2380 survey attempts. Among these, 861 were excluded for the following reasons: 842 were prematurely closed or incomplete, 10 reported hoax or illogic responses or were completed too rapidly, and 9 were completed by individuals who were not involved in strength-training exercise. These exclusions left 1519 respondents who participated in strength training and completed and submitted a valid survey.

Of the 1519 participants, 518 were self-reported AAS users and 1001 were not AAS users. Of the 518 AAS users, 506 were male and 12 were female. Of the 506 male AAS users, 479 completed the DSM-IV-TR adapted questionnaire for AAS dependence, resulting in a final analytic cohort of 112 AAS-dependent and 367 AAS-nondependent male users.

## Demographics

The demographic data comparing the AAS-dependent and AAS-nondependent users are summarized in Table 2. There were no statistically significant differences between the groups with regard to age, height, weight, body mass index, race-ethnicity, sexual orientation, and level of education; however, there were significant differences in marital status between groups, with a higher proportion of AAS-dependent users being married (34.8% vs 25.1%, p=0.043). The AAS-nondependent users were more likely than AAS-dependent users to be single (56.5% vs 45.5%, p=0.043).

The participants were instructed to classify themselves as recreational exercisers, competitive bodybuilders, competitive powerlifters or Olympic-style weightlifters, or competitive athletes. Although there were no significant differences between the AAS-dependent and AAS-nondependent users regarding their self-classification, over 70% of participants in both groups classified themselves as recreational exercisers. Only 16 AAS-dependent users (14.3%) were competitive bodybuilders, 9 (8.0%) were competitive powerlifters or Olympic-style weightlifters, and 8 (7.1%) were competitive athletes. High school sports

**Table 2. Characteristics of the Male Anabolic-Androgenic Steroid Users**

| Characteristic | AAS-Dependent Users (n=112) | AAS-Nondependent Users (n=367) | p Value |
|---|---|---|---|
| Age (yrs) | 29.6 ± 0.8 (18–57) | 29.1 ± 0.5 (16–73) | 0.578 |
| Height (cm) | 179.6 ± 0.8 (160.0–193.0) | 180.1 ± 0.5 (154.9–218.4) | 0.694 |
| Weight (kg) | 98.1 ± 1.3 (70.4–146.8) | 97.0 ± 0.8 (59.1–163.6) | 0.496 |
| Body mass index (kg/m$^2$) | 30.4 ± 0.4 (23.0–43.0) | 29.9 ± 0.2 (21.0–48.7) | 0.252 |
| Current or former high school athlete | 51 (45.5) | 144 (39.2) | 0.235 |
| Race-ethnicity | | | |
| Caucasian | 97 (86.6) | 339 (92.4) | 0.062 |
| Hispanic | 4 (3.6) | 16 (4.4) | 0.999 |
| Bi- or multiracial, or African-American | 2 (1.8) | 3 (0.8) | 0.333 |
| Asian or Pacific Islander | 2 (1.8) | 8 (2.2) | 0.999 |
| Middle Eastern | 5 (4.5) | 5 (1.4) | 0.059 |
| Marital status | | | |
| Single | 51 (45.5) | 207 (56.4) | 0.043 |
| Married | 39 (34.8) | 92 (25.1) | 0.043 |
| Divorced or separated | 9 (8.0) | 27 (7.4) | 0.838 |
| Living with a partner | 9 (8.0) | 34 (9.3) | 0.850 |
| Sexual orientation | | | |
| Heterosexual | 109 (97.3) | 354 (96.5) | 0.656 |
| Homosexual or bisexual | 3 (2.7) | 13 (3.5) | 0.656 |
| Education completed | | | |
| No high school degree or GED | 2 (1.8) | 6 (1.6) | 0.999 |
| High school degree or GED | 38 (33.9) | 111 (30.2) | 0.461 |
| Vocational/trade school | 12 (10.7) | 21 (5.7) | 0.068 |
| Associate's degree | 14 (12.5) | 63 (17.2) | 0.239 |
| Bachelor's degree or higher (e.g., Masters, Doctoral, Professional Degree) | 38 (33.9) | 142 (38.7) | 0.362 |
| Type of exercise participant | | | |
| Recreational exerciser | 79 (70.5) | 258 (70.3) | 0.962 |
| Competitive bodybuilder | 16 (14.3) | 42 (11.4) | 0.420 |
| Competitive powerlifter or Olympic-style weightlifter | 9 (8.0) | 31 (8.4) | 0.890 |
| Competitive athlete | 8 (7.1) | 36 (9.8) | 0.392 |

Data are mean ± SD (range) or no. (%) of survey respondents.
AAS = anabolic-androgenic steroids.

participation was not associated with an increased risk of being an AAS-dependent user (45.5% for AAS-dependent users vs 39.2% for AAS-nondependent users, p=0.235).

### Exercise Patterns

Participants who were AAS dependent had a similar numbers of years of strength-training experience and weekly time commitments dedicated to strength training as AAS-nondependent users. The AAS-dependent users had a mean ± SD of 10.3 ± 0.8 years of strength-training experience and spent 4.6 ± 0.1 days/week, for a total of 6.6 ± 0.3 hours/week, in strength-training exercise.

### Self-Perceived Body Weight Assessment

Participants were asked to critique their own body weight as "overweight," "underweight," or "just about right." Although a majority of both AAS-dependent and AAS-nondependent users felt their body weight was "just about right" (53.6% and 63.8%, respectively, p=0.053), AAS-dependent users were more likely than AAS-nondependent users to consider their weight as "underweight" (27.7 vs 14.7%, p=0.002). Participants were then asked if they were attempting to gain, lose, or maintain current body weight; over half of users in both the AAS-dependent and AAS-nondependent groups were attempting to gain weight (53.6 and 50.1%, respectively, p=0.524).

### Characteristics of Performance-Enhancing Agent and Anabolic-Androgenic Steroid Use

Table 3 provides data on the use of performance-enhancing agents and AAS for the AAS-dependent and AAS-nondependent users. For analytic purposes, performance-enhancing agents included both AAS and non-AAS agents. On average, AAS-dependent users incorporated more performance-enhancing agents in their routine during the year (12.8 ± 0.5 vs 10.7 ± 0.2 agents, p<0.001) and reported spending more money on performance-enhancing agents/year ($1770.56 ± 176.71 vs $1330.88 ± 80.61, p=0.012) than AAS-nondependent users.

Regarding AAS use, there were a number of differences between AAS-dependent and AAS-nondependent users. The AAS-dependent users utilized more AAS agents/steroid cycle (2.5 vs 2.1 agents/cycle, p=0.007), used almost 50% higher weekly AAS doses (1544.7 vs 1081.7 mg, p<0.001), and used AAS for more lifetime weeks (81.0 vs 51.6 wks, p=0.018) than AAS-nondependent users. Dependent users had similar "on cycles" but shorter "off periods" (15.1 vs 22.4 wks, p=0.034) between AAS cycles than AAS-nondependent users. Despite these differences, both AAS-dependent and nondependent users began using AAS at similar ages.

Usage of various types of non-AAS agents are reported in Table 4. The AAS-dependent users incorporated more non-AAS agents/year (10.4 vs 8.6 agents/yr, p<0.001) in their regimen than AAS-nondependent users. More than 50% of individuals in both groups used protein powder, creatine, multivitamins, fish oil, tamoxifen (an estrogen receptor antagonist), and anastrazole (an aromatase inhibitor). The AAS-dependent users were significantly more likely to use nutritional supplements such as amino acids and caffeine, and pharmaceuticals such as triiodothyronine, human growth hormone, tadalafil, sildenafil, insulin, and insulin-like growth factor 1, than AAS-nondependent users (p<0.05).

### Adverse Effects of Anabolic-Androgenic Steroids

Adverse effects of AAS use commonly reported by AAS-dependent and nondependent users are described in Figure 1. The AAS-dependent users were much more likely to experience injection-site pain, testicular atrophy, increased blood pressure, edema, mood changes, insomnia, striae and stretch marks, gynecomastia, sexual dysfunction, an abnormal lipid panel, and scalp hair loss than AAS-nondependent users.

The AAS-dependent users were more likely to be concerned with possible negative effects of AAS on their long-term health than AAS-nondependent users (68.8% vs 52.5%, p=0.002). Despite the adverse effects and concerns, the majority of both AAS-dependent and nondependent users planned to continue AAS use in the future (92.0% and 93.7%, respectively, p=0.512).

### Alcohol, Tobacco, and Illicit Drug Use

The AAS-dependent users were more likely to use heroin within the past 12 months than AAS-nondependent users (5.4% vs 1.9%, p=0.049). No significant differences were noted between AAS-dependent and AAS-nondependent users

**Table 3. Use of Performance-Enhancing Agents in the Male Anabolic-Androgenic Steroid Users**

| Characteristic | AAS-Dependent Users (n=112) | AAS-Nondependent Users (n=367) | p Value |
|---|---|---|---|
| Overall performance- enhancing agent use | | | |
| No. of performance-enhancing agents (AAS + non-AAS agents) used/yr | 12.8 ± 0.5 (4–27) | 10.7 ± 0.2 (1–29) | <0.001 |
| No. of non-AAS agents used/yr | 10.4 ± 0.4 (3–25) | 8.6 ± 0.2 (0–28) | <0.001 |
| No. of AAS agents used/cycle | 2.5 ± 0.1 (1–7) | 2.1 ± 0.1 (1–7) | 0.007 |
| Amount spent on performance-enhancing agents/yr ($) | 1770.56 ± 176.71 (0-10,000) | 1330.88 ± 80.61 (0-10,000) | 0.012 |
| AAS Use | | | |
| Age at onset of first AAS use (yrs) | 23.6 ± 0.6 (13–51) | 24.8 ± 0.4 (14–69) | 0.145 |
| Weekly AAS dose (mg) | 1544.7 ± 164.3 (70–12,600) | 1081.7 ± 44.0 (30–5630) | <0.001 |
| Duration of AAS cycle (wks) | 10.2 ± 0.4 (2–24) | 10.7 ± 0.2 (2–56) | 0.336 |
| Length of time off AAS (wks) | 15.1 ± 1.5 (1–100) | 22.4 ± 1.8 (2–400) | 0.034 |
| Lifetime duration of AAS use (wks) | 81.0 ± 11.2 (1–600) | 51.6 ± 5.9 (1–1560) | 0.018 |
| Had routine laboratory checks while using AAS | 52 (46.4) | 215/365[a] (58.9) | 0.020 |
| Concerned with possible negative effects of AAS on health | 77 (68.8) | 191/364[a] (52.5) | 0.002 |
| Informed physician or health care provider of AAS use | 40 (35.7) | 115 (31.3) | 0.417 |
| Plan to use AAS in future | 103 (92.0) | 344 (93.7) | 0.512 |

Data are mean ± SD (range) or no. (%) of survey respondents.
AAS = anabolic-androgenic steroid.
[a]Not all survey participants answered this question.

**Table 4. Types of Performance-Enhancing Agents Used by the Male Anabolic-Androgenic Steroid Users**

| Performance-Enhancing Agent | AAS-Dependent Users (n=112) | AAS-Nondependent Users (n=367) | p Value |
|---|---|---|---|
| Nutritional supplement | | | |
| Protein powder | 100 (89.3) | 317 (86.4) | 0.422 |
| Creatine | 97 (86.6) | 289 (78.7) | 0.066 |
| Multivitamin | 79 (70.5) | 254 (69.2) | 0.790 |
| Fish oil | 71 (63.4) | 231 (62.9) | 0.931 |
| Amino acids | 68 (60.7) | 181 (49.3) | 0.035 |
| Caffeine | 66 (58.9) | 174 (47.4) | 0.033 |
| Flaxseed oil | 39 (34.8) | 115 (31.3) | 0.489 |
| Yohimbine | 26 (23.2) | 70 (19.1) | 0.338 |
| Androstenedione | 24 (21.4) | 55 (15.0) | 0.108 |
| Dehydroepiandrosterone | 24 (21.4) | 82 (22.3) | 0.838 |
| Pharmaceutical | | | |
| Tamoxifen | 88 (78.6) | 273 (74.4) | 0.368 |
| Anastrazole | 47 (42.0) | 155 (42.2) | 0.960 |
| Ephedrine | 54 (48.2) | 141 (38.4) | 0.065 |
| Clomiphene | 46 (41.1) | 143 (39.0) | 0.690 |
| Clenbuterol | 43 (38.4) | 113 (30.8) | 0.133 |
| Human chorionic gonadotropin | 38 (33.9) | 110 (30.0) | 0.428 |
| Triiodothyronine | 33 (29.5) | 73 (19.9) | 0.033 |
| Human growth hormone | 29 (25.9) | 42 (11.4) | <0.001 |
| Tadalafil | 27 (24.1) | 37 (10.1) | <0.001 |
| Letrozole | 22 (19.6) | 63 (17.2) | 0.548 |
| Sildenafil | 21 (18.8) | 24 (6.5) | <0.001 |
| Insulin | 20 (17.9) | 15 (4.1) | <0.001 |
| Insulin-like growth factor 1 | 16 (14.3) | 27 (7.4) | 0.025 |
| Finasteride | 10 (8.9) | 21 (5.7) | 0.070 |

Data are no. (%) of survey respondents.
AAS = anabolic-androgenic steroids.

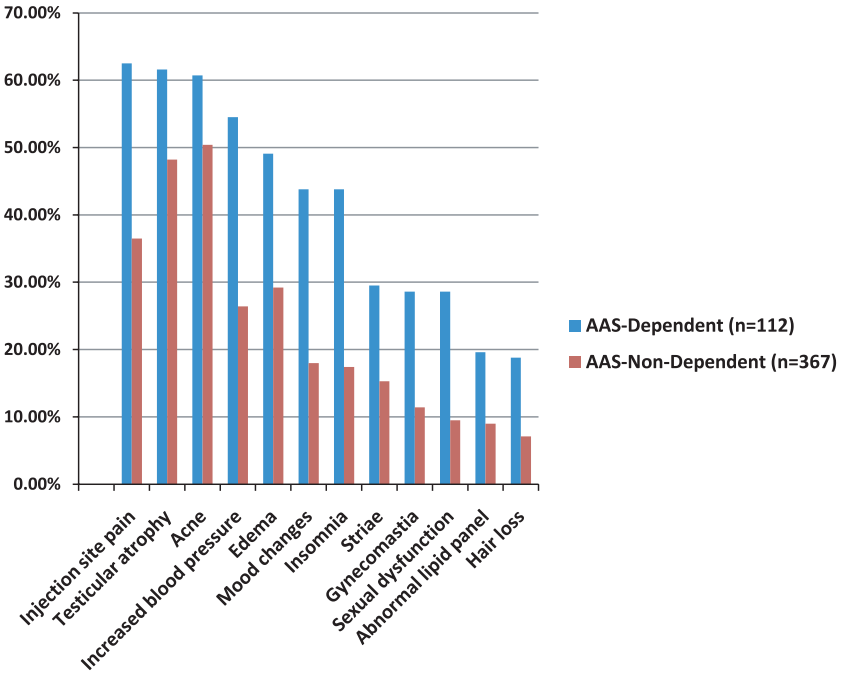


**Figure 1.** Proportions of anabolic-androgenic steroid (AAS)-related adverse effects in male AAS-dependent users versus AAS-nondependent users.

regarding binge alcohol drinking ($\geq$ 5 drinks on the same occasion; 46.4% vs 47.4%, p=0.855), heavy alcohol use ($\geq$ 5 drinks on the same occasion for 5 days or more within a 30-day period; 27.7% vs 22.9%, p=0.299), cigarette smoking (19.6% vs 24.8%, p=0.261), smokeless tobacco use (12.5% vs 15.0%, p=0.512), marijuana use (33.9% vs 30.2%, p=0.461), or cocaine use (12.5% vs 10.9%, p=0.639) within the past 12 months.

### Diagnosed Psychiatric Conditions and History of Sexual or Physical Abuse

Among the AAS-dependent users, 29 (25.9%) reported a health care professional psychiatric diagnosis compared with 57 AAS-nondependent users (15.5%, p=0.012; Table 5). The psychiatric diagnoses consisted of major depressive disorder, an anxiety disorder (generalized anxiety disorder, panic disorder, posttraumatic stress disorder, obsessive-compulsive disorder, or social phobia), attention-deficit–hyperactivity disorder, anorexia nervosa, or bulimia nervosa. Of those reporting a psychiatric diagnosis, AAS-dependent users were significantly more likely than AAS-nondependent users to report an anxiety disorder (16.1% vs 8.4%, p=0.020) and major depressive disorder (15.2% vs 7.4%, p=0.012).

No statistically significant differences were found between AAS-dependent and AAS-nondependent users with a history of sexual abuse (9.1% vs 5.2%, p=0.140) or physical abuse (12.7% vs 9.0%, p=0.256).

## Discussion

This study evaluated 479 men using AAS (112 AAS-dependent and 367 AAS-nondependent users), resulting in an estimated AAS dependence rate of 23.4%. The rate of AAS dependence in this study is consistent with 10 other studies spanning 20 years, where the rates ranged from 13.3–58.3% with a mean of roughly 30%.[4, 10–18] Data from the AAS-dependent users in our study were not significantly different with regard to age, race-ethnicity, sexual orientation, body weight, exercise patterns, strength-training experience, or education level relative to AAS-nondependent users. The majority of both groups classified themselves as recreational exercisers, suggesting that AAS dependence affects a substantial proportion of the strength-training population and is not limited to competitive bodybuilders, competitive powerlifters or Olympic-style weightlifters, or competitive athletes.

Male AAS-dependent users were almost twice as likely to consider their body weight as underweight compared with AAS-nondependent men,

**Table 5. Psychiatric Diagnoses and Sexual or Physical Abuse History in the Male Anabolic-Androgenic Steroid Users**

| | AAS-Dependent Users (n=112) | AAS-Nondependent Users (n=367) | p Value |
|---|---|---|---|
| Psychiatric diagnoses[a] | | | |
| Any psychiatric illness[b] | 29 (25.9) | 57 (15.5) | 0.012 |
| An anxiety disorder[c] | 18 (16.1) | 31 (8.4) | 0.020 |
| Major depressive disorder | 17 (15.2) | 27 (7.4) | 0.012 |
| ADHD | 7 (6.3) | 18 (4.9) | 0.575 |
| Anorexia nervosa | 1 (0.9) | 0 (0) | 0.234 |
| Bulimia nervosa | 1 (0.9) | 0 (0) | 0.234 |
| History of abuse[d] | | | |
| Sexual | 10/110 (9.1) | 19/363 (5.2) | 0.140 |
| Physical | 14/110 (12.7) | 33/365 (9.0) | 0.256 |

Data are no. (%) of survey respondents.
AAS = anabolic-androgenic steroids; ADHD = attention-deficit–hyperactivity disorder.
[a]From the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision*.[7]
[b]Major depressive disorder, an anxiety disorder, ADHD, anorexia nervosa, or bulimia nervosa.
[c]Generalized anxiety disorder, panic disorder, posttraumatic stress disorder, obsessive-compulsive disorder, or social phobia.
[d]Not all survey participants answered these questions.

and the majority of both groups were attempting to gain weight despite both groups having a mean body mass index greater than the normal range (18.5–24.9 kg/m$^2$).[20] This finding may be due to the fact that men in various parts of the world prefer their body to be muscular, which may cause body image issues and related behaviors.[21] The desire to become massive and muscular is a plausible driving force for AAS-dependent users to administer higher weekly doses of AAS, use a greater number of AAS agents/steroid cycle, have shorter off-periods of AAS use between cycles, and have an overall longer lifetime use (greater number of AAS cycles) than AAS-nondependent users.[12–14]

Similar to previous studies, our study observed a larger proportion of AAS-dependent users using higher doses of AAS and administering more lifetime AAS cycles than AAS-nondependent users.[10–12] Alarmingly, the study found that AAS-dependent users' more excessive patterns of AAS use were associated with a much higher frequency of self-reported AAS-related adverse effects. Of note, greater AAS use and an increase in AAS-related adverse effects among AAS-dependent users may be a result of an endogeneity issue where these characteristics are related to the AAS dependence definition. Regardless, a sizable proportion of AAS-dependent users utilized antiestrogens (e.g., tamoxifen, anastrazole), fertility agents (e.g., clomiphene, human chorionic gonadotropin), erectile dysfunction agents (e.g., tadalafil, sildenafil), and male-pattern baldness agents (e.g., finasteride) to counter the potential gynecomastia, testicular atrophy, sexual dysfunction, and scalp hair loss, respectively, associated with AAS use. Despite a majority of AAS-dependent individuals experiencing an AAS-related adverse effect and being concerned about the long-term health effects of AAS, the vast majority reported plans to continue AAS use. As such, AAS dependence may have public health implications as the decision to use AAS in an excessive manner may cause an increase in health care utilization and costs. Pharmacists, in collaboration with AAS users' physicians, may be able to play a role in screening for use of performance-enhancing agents and providing objective information to AAS users on the potential complications of polypharmacy.

Although there were no reported differences in alcohol, cigarette, smokeless tobacco, marijuana, or cocaine use within the past 12 months between AAS-dependent and nondependent users, AAS-dependent users were more than 2.5 times as likely to report illicit heroin use. The higher incidence of heroin abuse in our study coincides with the notion described in another clinical study—that AAS-dependent users are more likely to be dependent on or abuse opioid drugs.[11] Heroin, like morphine, belongs to the opioid class but is primarily considered a "street drug" in the United States. Although the onset of opioid dependence or abuse could not be chronologically correlated with AAS use and dependence in that clinical study,[11] several animal studies support the concept that AAS and opioids may affect or share analogous brain mechanisms, neurotransmitters, and receptors.[22] An apparent association links AAS dependence with illicit heroin use, opioid drug dependence, and opioid abuse. Unlike a previous study that reported no significant differences in anxiety or major mood disorders between AAS-dependent

and AAS-nondependent users,[11] our study observed that AAS-dependent users were approximately twice as likely to report a lifetime history of an anxiety disorder or major depressive disorder relative to AAS-nondependent users. Suppression of the hypothalamic-pituitary-gonadal axis by AAS has been reported to predispose some AAS users to psychiatric depression during the hypogonadal state and may be a possible reason for the increased frequency of major depressive disorder.[23] It is not possible, however, to determine if the reported increases in anxiety or major depressive disorder in our study were a result of AAS use and dependence or if the disorders were present before starting AAS. Similar to findings from the previous trial,[11] there were no significant differences regarding history of attention-deficit–hyperactivity disorder, anorexia nervosa, or bulimia nervosa between AAS-dependent and AAS-nondependent users. Whether our findings represent true differences, are the result of different study populations, or are due to differing investigator techniques remain unknown. Our study relied on participants to identify their diagnosed DSM disorders through an online survey whereas the previous trial[11] used an in-person Structured Clinical Interview for DSM-IV.[24] Future studies may want to examine the underlying causes of AAS dependence and the possible causality with anxiety or major depressive disorders. Such a study would better outline the feasibility of targeted interventions to treat and prevent AAS dependence and its health consequences.

### Limitations

There are several limitations of this study that require consideration. First, survey studies by nature lend to recall bias, as participants must remember their encounters. Second, although surveys are valuable in collecting general information about a particular population, cross-sectional data do not allow for the determination of causality. Third, Internet discussion boards were the sole source of participant recruitment and survey administration. Selection bias exists, as individuals without Internet access or those who do not frequent online discussion boards would, by design, be excluded. Finally, the identification of behaviors consistent with AAS dependence was based solely on self-reporting by participants and may overestimate the actual frequency of the disorder in our study population; however, consistencies of information with this study and other surveys on AAS dependence support the veracity of our results.[4, 10–18] Various sources have also demonstrated the validity and reliability of Web-based data collection for survey research when compared with traditional methods.[25–27]

## Conclusion

Anabolic-androgenic steroid dependence affects a substantial number of AAS users, and behaviors consistent with this disorder were identified in nearly one quarter (23.4%) of the male users in this study. Compared with AAS-nondependent users, AAS-dependent users were more excessive in their AAS use (e.g., higher doses, higher quantity of agents, shorter "off" periods, longer lifetime duration of use) and used more performance-enhancing agents in their routine regimens. The AAD-dependent users were also more likely to report a history of heroin use within the last 12 months as well as a diagnosis of an anxiety disorder or major depressive disorder than AAS-nondependent users. These findings can help clinicians and researchers better understand and address the potential complications of polypharmacy, illicit drug use, and psychiatric comorbidities that may be present among AAS-dependent users.

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