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Abstract

Objective: To compare and contrast the characteristics of 2 groups of men ≥ 40 years old: reported anabolic–androgenic steroid (AAS) users and nonusers. **Design:** Cross-sectional survey. **Setting:** Thirty-eight online fitness, weight lifting, bodybuilding, and steroid Web sites. **Participants:** A total of 67 male AAS users and 76 male nonusers ≥ 40 years old. **Main Outcomes Measured:** Demographics, utilization of AAS and other performance-enhancing agents (PEAs), exercise patterns, history of illicit drugs and alcohol use, and psychiatric traits/diagnoses. **Results:** The majority of AAS users ≥ 40 years old were caucasian (92.5%), heterosexual (97.0%), and classified themselves as recreational exercisers (79.1%). AAS users took more PEAs (11.5 ± 5.6 vs 4.6 ± 2.7 ; $P < .001$), were more likely to binge drink (47.8% vs 29.0%; $P = .025$), report heavy alcohol use (21.0% vs 7.9%; $P = .031$), meet criteria for substance dependence disorder (27.4% vs 4.0%; $P < .001$), and report an anxiety disorder diagnosis (12.0% vs 2.6%; $P = .046$) than nonusers. **Conclusions:** AAS misuse is prevalent among older men and is associated with polypharmacy, more aggressive alcohol use, and a higher incidence of substance dependence and anxiety disorders compared to nonusers. This information may help clinicians and researchers identify and develop appropriate intervention strategies for AAS abuse among older men.

Keywords

anabolic–androgenic steroids, anabolic steroids, older men, abuse, males

Introduction

Anabolic–androgenic steroids (AASs) are a class of drugs that include testosterone and its synthetic derivatives. Over the decades, researchers have conducted cross-sectional studies depicting the use of AAS in the young adult and pediatric populations. AAS use remains popular among young adult males due to their desire to enhance physical appearance, muscle size, and strength.¹⁻⁴

Although the current literature suggests that the majority of AAS users are in their late 20s and early 30s, a subset of individuals over 40 years old also appears to abuse AAS.³⁻⁶ However, little information is known about this cohort as studies have not specifically targeted this group. Some studies have provided facts about older AAS users in their analysis. Cohen and colleagues found that the primary motivation of use for older AAS users was to decrease body fat.⁵ Hakansson and colleagues found that the lifetime history of AAS use was significantly associated with older age.⁶ However, both of these studies did not clearly define what constituted “older AAS users.” One study was not statistically powered to compare the characteristics of older AAS users to those of nonusers.⁷ Yesalis and colleagues conducted a study using data from the National Household Survey on Drug Abuse and was unable to

report significant results in the lifetime use of AAS for users over 35 years old due to either low precision from their analysis or no reported estimate in their data.⁷ To our knowledge, our study is the first to provide an in-depth analysis of older AAS-using men.

The current study is a subanalysis from the Anabolic 500, a Web-based cross-sectional survey of AAS users ranging from 16 to 73 years of age.³ It is comprised of data from 518 AAS users (506 male and 12 female). The purpose is to compare and contrast 2 groups of men ≥ 40 years old: those who reported AAS use versus those who reported no AAS use. Findings from this study may help clinicians and researchers identify AAS users in the older male population and aid in the development of appropriate intervention strategies for AAS abuse.

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Study Methods

Study Design and Patient Population

A 99-item Web-based survey was administered through SurveyMonkey (Palo Alto, California) to assess the characteristics of men who participated in strength-training exercises.³ The current subanalysis includes only male subjects ≥ 40 years old who were self-reported AAS users or nonusers. Variables assessed were demographics, exercise patterns, AAS utilization and other performance-enhancing agents (PEAs), reasons for AAS use, history of illicit drug and alcohol use, behavior consistent with *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition, Text Revision; *DSM-IV-TR*) criteria for substance dependence disorder (SDD), *DSM-IV-TR* psychiatric conditions diagnosed by a health care professional, and history of sexual or physical abuse.

Participants were eligible to take part in the survey if they had Internet access and regularly participated in strength-training exercise. Data from prematurely closed or incomplete surveys (ie, not reaching the end of the survey), surveys with hoax or illogical responses, and surveys filled out too quickly (< 5 minutes for a self-reported AAS user and < 3 minutes for a nonuser) were excluded from the study. A pilot test of 15 weight lifters demonstrated that the average AAS user and nonuser spent roughly 30 minutes and 10 minutes, respectively, to complete the survey.

Data Collection and Data Security

Participants were recruited from 38 online discussion boards of various fitness, bodybuilding, weight lifting, and anabolic steroid Web sites between February 19 and June 30, 2009. The "Touro 12-Step" strategy was applied to enhance survey participation on Internet discussion boards.⁸ Internet discussion boards were selected if the site was currently active and had over 500 members. A survey Web link directed potential participants to an informed consent page providing additional information regarding the study and detailed procedures used to maintain confidentiality and anonymity. There was no individually identifiable data collected, Internet provider addresses were not logged, and data transfers were encrypted. Only researchers who were identified in the institutional review board proposal and who completed a National Institutes of Health human subjects training program had access to the data. The study received institutional review board approval from Touro University California.

Statistical Analysis

All statistical analyses were conducted using SAS for Windows, version 9.1 (SAS Institute Inc, Cary, North Carolina). The survey data were primarily analyzed using descriptive statistics. Categorical data were reported as numbers and percentages of respondents and continuous data as mean \pm standard deviation. For determining statistical significance, the 2-tailed Fisher's exact test and Student's *t*-test were

utilized for categorical and continuous variables, respectively. A *P* value of $< .05$ was considered to indicate a statistically significant difference.

Results

When the survey closed on June 30, 2009, there were 2380 survey attempts. Among these, 861 surveys 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 exercises. These exclusions resulted in a final analytic cohort of 1519 subjects who fully completed and submitted a valid survey response. The completion response rate was 63.8%. Among the 1519 subjects, 143 were men ≥ 40 years old, of which 67 were AAS users and 76 reported no AAS use.

Demographics

The demographic data comparing AAS users and nonusers ≥ 40 years old are summarized in Table 1. There were no statistically significant differences between the 2 groups in regard to age, height, weight, body mass index, ethnicity, and sexual orientation.

The majority of AAS users were caucasian (96.9%), heterosexual (97.0%), and classified themselves as recreational exercisers (79.1%). Only 10.5% of AAS users were competitive bodybuilders while 4.5% classified themselves as competitive weight lifters and 6.0% as competitive athletes. The 2 cohorts did not significantly differ in terms of history of high-school sports participation (67.0% vs 54.0%, *P* = .125).

Exercise Patterns

AAS users engaged in strength training more days/week (4.5 ± 0.9 vs 3.7 ± 1.1 days/wk, *P* $< .001$) and hours/week (5.9 ± 0.4 vs 4.7 ± 2.4 hours/wk, *P* = .013) than nonusers.

Overall Performance Enhancing Agent Utilization

PEA utilization between the 2 groups is shown in Table 2. For analytical purposes, the PEA history included both AAS and non-AAS agents. Some AAS agents used by the AAS users included: testosterone enanthate, testosterone cypionate, trenbolone, methandrostenolone, and nandrolone. On average, AAS users incorporated 2.5 times more PEAs in their workout routine (11.5 ± 5.6 vs 4.6 ± 2.7 agents, *P* $< .001$) than nonusers. AAS users also spent almost 3 times more money on PEAs per year than nonusers (US\$1719.38 \pm 1399.30 per year vs US\$602.15 \pm 545.11, *P* $< .001$).

The various types of non-AAS PEAs available are reported in Table 3. AAS users were more likely to use tamoxifen, anastrozole, clomiphene citrate, clenbuterol, tadalafil, human chorionic gonadotropin, human growth hormone, flax seed oil, dehydroepiandrosterone, ephedrine, yohimbine, insulin, and insulin-like growth factors (*P* $< .05$). More than 50% of survey

Table 1. Demographics of Anabolic–Androgenic Steroid Users and Nonusers ≥ 40 Years Old.^a

Characteristics	AAS users ≥ 40 yrs (n = 67)	AAS nonusers ≥ 40 yrs (n = 76)	P value
Age, years	47.3 \pm 6.7 (40-73)	45.5 \pm 5.1 (40-59)	.066
Height, cm	178.6 \pm 7.6 (160.0-198.1)	178.3 \pm 7.3 (162.6-198.1)	.810
Weight, kg	97.7 \pm 15.8 (59.1-145.5)	93.8 \pm 17.8 (68.2-144.5)	.176
Body mass index, kg/m ²	30.5 \pm 4.3 (20.4-43.0)	29.4 \pm 5.1 (22.1-48.3)	.170
Former high school athlete	45 (67.2)	41 (54.0)	.125
Ethnicity			
Caucasian	62 (92.5)	68 (89.5)	.233
Hispanic	1 (1.5)	0	–
Asian or Pacific Islander	0	1 (1.3)	–
Sexual orientation			
Heterosexual	65 (97.0)	73 (98.7)	.604
Homosexual or bisexual	2 (3.0)	1 (1.4)	.604
Type of exercise participant			
Recreational exerciser	53 (79.1)	65 (85.5)	.380
Competitive bodybuilder	7 (10.5)	2 (2.6)	.083
Competitive weightlifter	3 (4.5)	5 (6.6)	.723
Competitive athlete	4 (6.0)	4 (5.3)	.999

Abbreviations: AAS, anabolic–androgenic steroid; SD, standard deviation.

^aData are mean \pm SD (range) or no. (percentage) of survey respondents.

Table 2. Exercise Patterns and Performance-Enhancing Agent Utilization in Male Anabolic–Androgenic Steroid Users and Nonusers ≥ 40 Years Old.^a

Characteristics	AAS users ≥ 40 yrs (n = 67)	AAS nonusers ≥ 40 yrs (n = 76)	P value
Exercise patterns			
Years of strength training	19.8 \pm 11.5 (1-56)	16.1 \pm 38.4 (0.5-325)	.458
Days/week of strength training	4.5 \pm 0.9 (3-6)	3.7 \pm 1.1 (1-6)	<.001
Hours/week of strength training	5.9 \pm 0.4 (1-18)	4.7 \pm 2.4 (1.5-15.0)	.013
Overall PEA use			
No. of PEAs (AAS + non-AAS agents)/yr	11.5 \pm 5.6 (0-29)	4.6 \pm 2.7 (0-14)	<.001
No. of AAS agents used/cycle	2.2 \pm 1.3 (0-7)	0	<.001
No. of non-AAS used/yr	9.3 \pm 5.1 (0-28)	4.6 \pm 2.7 (0-14)	<.001
Amount spent on PEAs/yr, US\$	1719.38 \pm 1399.30 (0-7000)	602.15 \pm 545.11 (0-3000)	<.001
Characteristics of AAS use			
Age onset of first AAS use, yrs	34.4 \pm 11.8 (17-69)	–	–
Weekly AAS dose, mg	1103.6 \pm 1165.6 (35-6850)	–	–
Plan to use AAS in future	57 (86.4)	4 (5.5)	<.001

Abbreviations: AAS, anabolic–androgenic steroids; PEAs, performance-enhancing agents; SD, standard deviation.

^aData are mean \pm SD (range) or no. (percentage) of survey respondents.

participants in both groups used creatine, multivitamins, protein powder, amino acids, and fish oil.

Characteristics of AASs Use

As shown in Table 2, the age of onset for first AAS use was 34.4 \pm 11.8 years old. The average weekly AAS dose administered or ingested was 1103.6 \pm 1165.6 mg. They used 2.2 \pm 1.3 AAS agents per drug cycle. The majority (86.4%) of AAS users planned to continue using AAS in the future.

Motivations for Use

Table 4 presents a summary of rankings of the motivations for using AAS. The rankings were based upon a 5-point Likert-

type scale (5 = “very important,” 4 = “important,” 3 = “somewhat important,” 2 = “of little importance,” and 1 = “not a reason for use”). AAS users rated increase muscle mass, increase strength, and improve physical appearance as important to very important reasons for using AAS. They also ranked “slow the aging process” as somewhat important to important.

Alcohol, Tobacco, and Illicit Drug Use

Alcohol, tobacco and illicit drug use in AAS users and nonusers are summarized in Table 5. AAS users were more likely to binge drink (defined as ≥ 5 drinks on the same occasion; 47.8% vs 29.0%, $P = .025$) and take part in heavy alcohol use (defined as ≥ 5 drinks on the same occasion for ≥ 5 days within a 30-day period; 21.0% vs 7.9%, $P = .031$) within the

Table 3. Types of Performance-Enhancing Agents Taken by Anabolic-Androgenic Steroid Users and Nonusers ≥ 40 Years Old.^a

Performance-enhancing agents	AAS users ≥ 40 yrs (n = 67)	AAS nonusers ≥ 40 yrs (n = 76)	P value
Protein powder	57 (85.1)	60 (80.0)	.390
Creatine	49 (73.1)	44 (57.9)	.079
Multivitamin	43 (64.2)	50 (65.8)	.862
Fish oil	39 (58.2)	51 (67.1)	.301
Tamoxifen	38 (56.7)	1 (1.3)	<.001
Amino acids	34 (50.8)	29 (38.2)	.177
Clomiphene	27 (40.3)	1 (1.3)	<.001
Anastrozole	26 (38.8)	1 (1.3)	<.001
Flaxseed oil	26 (38.8)	13 (17.1)	.005
Caffeine	26 (38.8)	29 (38.2)	.999
Human growth hormone	24 (35.8)	0 (0)	<.001
Dehydroepiandrosterone	23 (34.3)	12 (15.8)	.012
Human chorionic gonadotropin	23 (34.3)	0 (0)	<.001
Ephedrine	19 (28.4)	10 (13.1)	.036
Clenbuterol	16 (23.9)	0 (0)	<.001
Levothyroxine	15 (22.4)	0 (0)	<.001
Tadalafil	14 (20.9)	1 (1.3)	<.001
Androstenedione	13 (19.4)	4 (5.3)	.010
Letrozole	12 (17.9)	0 (0)	<.001
Sildenafil	11 (16.4)	2 (2.6)	.007
Yohimbine	11 (16.4)	3 (4.0)	.021
Insulin	9 (13.4)	0 (0)	<.001
Insulin-like growth factors	8 (11.9)	0 (0)	.002
γ -Hydroxybutyric acid	4 (6.0)	0 (0)	.046

Abbreviation: AAS, anabolic-androgenic steroids.

^aData are no. (percentage) of survey respondents.

Table 4. Anabolic-Androgenic Steroid Users' Rating of Motivations for Anabolic-Androgenic Steroid Use.^a

Motivation	Score ^b
Increase muscle mass	4.4 \pm 0.9
Increase strength	4.3 \pm 0.9
Improve physical appearance	4.0 \pm 1.0
Slow the aging process	3.6 \pm 1.6
Prevent injury	2.8 \pm 1.4
Increase endurance	2.8 \pm 1.3
Improve sports performance	2.5 \pm 1.5
Increase sex drive/improve sexual function	2.5 \pm 1.5
Weight loss	2.4 \pm 1.4
Pressure to perform	1.5 \pm 1.1
Acceptance of peers	1.4 \pm 0.9
Increase aggression	1.3 \pm 0.6
For personal protection	1.3 \pm 0.8

Abbreviation: SD, standard deviation.

^aData are mean \pm SD.

^bScores range from 1 to 5: 1 = not a reason for use; 2 = of little importance; 3 = somewhat important; 4 = important; and 5 = very important.

past 12 months than nonusers. There were no significant differences between AAS users and nonusers regarding cigarette smoking or use of smokeless tobacco, marijuana, cocaine, or heroin within the past 12 months.

SDD and Diagnosed Psychiatric Conditions

SDD is a pattern of substance use that leads to significant impairment or distress. As stated by the *DSM-IV-TR*, SDD is marked by 3 or more symptoms shown⁹ in Table 6. The commonly reported symptoms among AAS users were the need to use increased amounts of PEAs (35.5% vs 9.2%, $P < .001$), a decreased effect with use of the same doses of PEAs (35.5% vs 4.0%, $P < .001$), and the need to take larger amounts of PEAs over a longer period of time (22.6% vs 4.0%, $P = .001$). More AAS users than nonusers met the *DSM-IV-TR* criteria for SDD (27.4% vs 4.0%, $P < .001$).

Regarding diagnosed psychiatric conditions (Table 7), AAS users were more likely to report an anxiety disorder (generalized anxiety disorder, panic disorder, post-traumatic stress disorder, obsessive-compulsive disorder, or social phobia) than nonusers (12.0% vs 2.6%, $P = .046$). No statistical differences were seen between the 2 groups regarding incidence of major depressive disorder, attention deficit hyperactivity disorder, anorexia nervosa, or bulimia nervosa.

Sexual or Physical Abuse

Table 7 also provides a summary of sexual or physical abuse history among AAS and nonusers. AAS users and nonusers did not differ significantly for history of sexual or physical abuse.

Discussion

The majority of AAS users over 40 years old in the current study were caucasian, heterosexual, and classified themselves as recreational exercisers. These demographics were similar to those reported in previous studies that included a broader age range of AAS users.^{3-6,10}

Both AAS users and nonusers in this study practiced polypharmacy using multiple PEAs in their routine. However, AAS users incorporated significantly more PEAs and spent more money on these agents than nonusers. AAS users commonly reported taking tamoxifen, anastrozole, clomiphene citrate, human chorionic gonadotropin, tadalafil, and sildenafil, agents used to prevent or counter adverse effects associated with AAS use. AAS users commonly take antiestrogens such as tamoxifen and anastrozole to treat or prevent AAS-induced gynecomastia.¹¹ Clomiphene citrate and human chorionic gonadotropin are fertility-enhancing agents used to treat or prevent AAS-induced testicular atrophy.^{12,13} AAS users take phosphodiesterase inhibitors (eg, tadalafil or sildenafil) to treat erectile dysfunction. A possible cause of increased phosphodiesterase inhibitor use may be due to suppression of endogenous testosterone production leading to hypogonadism from chronic AAS administration. Despite the potential for AAS-related adverse effects, AAS users were not deterred from its use and actually incorporated more agents to compensate for adverse effects. Further, AAS users also reported taking suprathreshold doses of AAS. In this study, the weekly AAS dose (which included both testosterone esters and synthetic derivatives) was 1103.6 ± 1165.6 mg, which is 11 times greater

Table 5. Alcohol, Cigarette Smoking, Smokeless Tobacco, or Illicit Drug Activity in Anabolic–Androgenic Steroid Users and Nonusers ≥ 40 Years Old.^a

Activity	AAS users ≥ 40 yrs (n = 67)	AAS nonusers ≥ 40 yrs (n = 76)	P value
Binge drinking ^b within the past 12 months	32 (47.8)	22 (29.0)	.025
Heavy alcohol ^c use within the past 12 months	14 (21.0)	6 (7.9)	.031
Cigarette smoking within the past 12 months	14 (21.0)	11 (14.5)	.380
Marijuana use within the 12 months	11 (16.4)	7 (9.2)	.216
Smokeless tobacco use within the past 12 months	7 (10.5)	5 (6.6)	.548
Cocaine use within the 12 months	6 (9.0)	2 (2.6)	.147
Heroin use within the 12 months	0 (0)	1 (1.3)	.999

Abbreviation: AAS, anabolic–androgenic steroids.

^aData are no. (percentage) of survey respondents.

^bBinge alcohol use = 5 or more drinks on the same occasion.

^cHeavy alcohol use = 5 or more drinks on the same occasion for 5 or more days within a 30-day period.

Table 6. DSM-IV-TR Criteria for Substance Dependence in Anabolic–Androgenic Steroid Users and Nonusers ≥ 40 Years Old.^a

Criteria for substance dependence	AAS users ≥ 40 yrs (n = 67)	AAS nonusers ≥ 40 yrs (n = 76)	P value
A need to use increased amounts of PEAs to achieve the desired effect	22 (35.5)	7 (9.2)	<.001
Taking larger amounts of PEAs over a longer period of time than originally intended	14 (22.6)	3 (4.0)	.001
A decreased effect with the use of the same dose of PEAs	22 (35.5)	3 (4.0)	<.001
Physical or emotional problems when PEAs were stopped	11 (17.7)	5 (6.6)	.060
Restarting PEAs to relieve problems/symptoms that occurred when originally stopped	10 (16.1)	5 (6.6)	.099
Spending a great deal of time in activities related to obtaining PEAs	8 (12.9)	2 (2.6)	.043
Continued use of PEAs despite experiencing physical, emotional, or social problems caused by PEAs	5 (8.1)	0 (0)	.017
Having the desire to or making unsuccessful efforts to decrease the amount of PEAs taken	5 (8.1)	1 (1.3)	.090
Quitting or reducing social, occupational, or recreational activities because of PEA use	1 (1.6)	0 (0)	.449
Meets criteria for substance dependence (≥ 3 symptoms)	17 (27.4)	3 (4.0)	<.001

Abbreviations: AASs, anabolic–androgenic steroids; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition, Text Revision); PEA, performance enhancing agent.

^aData are no. (percentage) of survey respondents.

Table 7. DSM-IV-TR Psychiatric Diagnoses and Sexual or Physical Abuse History in Anabolic–Androgenic Steroid Users and Nonusers ≥ 40 Years Old.^a

Diagnosis/history of abuse	AAS users ≥ 40 yrs (n = 67) ^b	AAS nonusers ≥ 40 yrs (n = 76) ^c	P value
Any psychiatric illness ^d	11 (16.4)	6 (7.9)	.129
An anxiety disorder ^e	8 (12.0)	2 (2.6)	.046
Major depressive disorder	6 (9.0)	4 (5.3)	.516
ADHD	3 (4.5)	2 (2.6)	.665
Sexually abused	8/65 (12.3)	6 (7.9)	.411
Physically abused	9/64 (14.1)	6/75 (8.0)	.283

Abbreviations: AAS, anabolic–androgenic steroid; ADHD, attention deficit hyperactivity disorder; DSM-IV-TR, *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition, Text Revision).

^aData are no. (percentage) of survey respondents.

^b67 unless otherwise reported.

^c76 unless otherwise reported.

^dMajor depressive disorder, an anxiety disorder, ADHD, anorexia nervosa, or bulimia nervosa.

^eGeneralized anxiety disorder, panic disorder, post-traumatic stress disorder, obsessive-compulsive disorder, or social phobia.

than the recommended dose in testosterone replacement therapy for patients with hypogonadism.¹⁴ Studies have demonstrated there is a dose-dependent relationship with AAS dose and its anabolic effects on muscle mass and strength, which may be a reason for such high doses being administered.^{15,16}

In terms of exercise patterns, the AAS users spent significantly more time strength training than nonusers. The exercise patterns in the over 40-year-old cohort were similar to those of the AAS users in the general population.^{3,4,17,18} As men age beyond 35 to 40 years old, there is a 1% to 3% decline per year

in circulating testosterone concentration in the body.^{19,20} A decrease in testosterone can cause a gradual decline in muscle size and strength. Further, a loss of lean body mass, specifically skeletal muscle, and decreased muscular strength associated with aging can exert a negative influence on one's physical function and long-term health.²¹ Resistance exercise (eg, strength training), on the other hand, can be an effective stimulator of muscle protein synthesis, which can counter age-related decline in muscle mass.²² Leone and Fetro reported that men over 35 years old viewed weight training and fitness maintenance as ways to enhance their quality of life and to become more health conscious.²³ Increasing resistance exercise appears to be 1 method the AAS users were employing to reverse the aging process.

Another method to "slow the aging process" was utilizing AAS, which was considered a "somewhat important" to "important" reason for use. This was not a reason for AAS use in the Anabolic 500, which involved a greater proportion of younger AAS users. However, similar to the younger population, older AAS users in our study utilized AAS to increase muscle mass, increase strength, and improve physical appearance.³ Over the decades, society's perception of the male body has become more muscular in appearance, especially in male magazine photos.²⁴ AAS users likely feel the societal pressures to achieve this muscular ideal. Further, Leone and Fetro found that middle-aged males believe that others utilize AAS because they live in a "result-based society" and how a person looks "defines their level of masculinity."²³ This suggests that the physiological decline due to aging in combination with society's body image pressures are contributing factors for AAS use in older men.

AAS users over 40 years old in the current study demonstrated more aggressive alcohol-related behaviors. AAS users were more likely than nonusers to binge drink and partake in heavy alcohol use. These results differ from our team's prior study (involving younger AAS users), which showed no significant difference between AAS users and nonusers.³ The percentage of AAS users who were found to binge drink in our study was also greater in comparison to current drinkers in the general older adult population. It is important to note that our study characterized binge drinking as ≥ 5 drinks/occasion. As such, 47.8% of AAS users ≥ 40 years old were found to partake in binge drinking within the past 12 months. Among current drinkers in the general older adult population, only 30% of men ≥ 60 years old consumed ≥ 3 drinks on 1 occasion.^{25,26} AAS users ≥ 40 years old were more aggressive in their alcohol intake than nonusers in our study, as well as current drinkers in the general older adult population. Whether more aggressive alcohol-use behaviors are the result of AAS or existed prior to starting AAS could not be determined from this study.

AAS users were associated with more psychiatric conditions. The SDD assessment found that AAS users ≥ 40 years old were more than 6 times as likely than nonusers to meet the *DSM-IV-TR* criteria for SDD (27.4% vs 4.0%). The rate of SDD for AAS users ≥ 40 years old was similar to other AAS-using populations, suggesting that age may not play a major role in

SDD development.^{3,4,27-29} In addition, AAS users in this analysis were more than 4 times as likely than nonusers to report a professional diagnosis of an anxiety disorder. Perhaps the reason for the increased alcohol use mentioned earlier may have been due to heightened levels of anxiety. One study found that AAS exposure in Syrian hamsters raised anxiety levels during AAS withdrawal.³⁰ Future studies may wish to further investigate whether anxiety is a cause or consequence of AAS use.

Limitations

Various limitations to this study require consideration. First, survey studies by nature lead to information bias due to participants needing to recall their experiences. Second, although surveys are an efficient tool in obtaining general information about the target population, cross-sectional data makes it difficult to determine causality. Next, the Internet and selected discussion boards were the source for all recruitment and survey administration, which may result in selection bias and may not be generalizable to the entire AAS-using population. However, the demographic characteristics and the incidence of AAS dependence in our study were similar to prior AAS studies.^{3-5,27} Further, various studies have demonstrated the validity and reliability of an Internet-based data collection for research when compared with traditional methods.³¹⁻³³ The Internet may provide a broader and more geographically diverse population than traditional surveys (ie, paper-and-pencil or telephone survey).³²

Conclusion

AAS abuse is prevalent among the older males who participated in the survey. The average AAS user over 40 years old in our study was caucasian, heterosexual, and classified himself as a recreational exerciser. The majority of AAS users in this sample were more likely than nonusers to spend more time strength training and practicing polypharmacy. Motivating factors for AAS use included: "increase muscle mass," "increase strength," "improve physical appearance," and also "slow the aging process." AAS users were more likely to binge drink and report heavy alcohol use within the past 12 months than nonusers. AAS users were also more likely to meet the criteria for SDD and report a diagnosis of an anxiety disorder. The findings in this study can help clinicians and researchers better understand the older AAS-using population, which may lead to improved identification and potential interventions in the older male population.

Declaration of Conflicting Interests

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References

1. Buckley WE, Yesalis CE III, Friedl KE, et al. Estimated prevalence of anabolic steroid use among male high school seniors. *JAMA*. 1988;260(23):3441-3445.
2. Johnson MD, Jay MS, Shoup B, et al. Anabolic steroid use by male adolescents. *Pediatrics*. 1989;83(6):921-924.
3. Ip EJ, Barnett MJ, Tenerowicz MJ, et al. The anabolic 500 survey: characteristics of male users versus nonusers of anabolic-androgenic steroids for strength training. *Pharmacotherapy*. 2011; 31(8):757-766.
4. Perry PJ, Lund BC, Deninger MJ, et al. Anabolic steroid use in weightlifters and bodybuilders: an internet survey of drug utilization. *Clin J Sport Med*. 2005;15(5):326-330.
5. Cohen J, Collins R, Darkes J, et al. A league of their own: demographics, motivations and patterns of use of 1,955 male adult non-medical anabolic steroid users in the United States. *J Int Soc Sports Nutr*. 2007;4:12.
6. Hakansson A, Mickelsson K, Wallin C, et al. Anabolic androgenic steroids in the general population: user characteristics and associations with substance use. *Eur Addict Res*. 2012;18(2): 83-90.
7. Yesalis CE, Kennedy NJ, Kopstein AN, et al. Anabolic-androgenic steroid use in the United States. *JAMA*. 1993;270(10): 1217-1221.
8. Ip EJ, Barnett MJ, Tenerowicz MJ, et al. The Touro 12-step: a systematic guide to optimizing survey research with online discussion boards. *J Med Internet Res*. 2010;12(2):e16.
9. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders, 4th ed, Text Revision (DSM-IV-TR)*. Washington, DC: American Psychiatric Association; 2000.
10. Parkinson AB, Evans NA. Anabolic androgenic steroids: a survey of 500 users. *Med Sci Sports Exerc*. 2006;38(4):644-651.
11. Hanavadi S, Banerjee D, Monypenny II, et al. The role of tamoxifen in the management of gynaecomastia. *Breast*. 2006;15(2): 276-280.
12. Martikainen H, Alén M, Rahkila P, et al. Testicular responsiveness to human chorionic gonadotrophin during transient hypogonadotrophic hypogonadism induced by androgenic/anabolic steroids in power athletes. *J Steroid Biochem*. 1986;25(1):109-112.
13. Tan RS, Vasudevan D. Use of clomiphene citrate to reverse premature andropause secondary to steroid abuse. *Fertil Steril*. 2003; 79(1):203-205.
14. Bhasin S, Cunningham GR, Hayes FJ, et al. Testosterone therapy in adult men with androgen deficiency syndromes: an endocrine society clinical practice guideline. *J Clin Endocrinol Metab*. 2006;91(6):1995-2010.
15. Friedl KE, Dettori JR, Hannan CJ Jr, et al. Comparison of the effects of high dose testosterone and 19-nortestosterone to a replacement dose of testosterone on strength and body composition in normal men. *J Steroid Biochem Mol Biol*. 1991;40(4-6):607-612.
16. Sinha-Hikim I, Artaza J, Woodhouse L, et al. Testosterone-induced increase in muscle size in healthy young men is associated with muscle fiber hypertrophy. *Am J Physiol Endocrinol Metab*. 2002;283(1):E154-E164.
17. Hildebrandt T, Alfano L, Langenbucher JW. Body image disturbance in 1000 male appearance and performance enhancing drug users. *J Psychiatr Res*. 2010;44(13):841-846.
18. Leifman H, Rehnman C, Sjöblom E, et al. Anabolic androgenic steroids—use and correlates among gym users—an assessment study using questionnaires and observations at gyms in the Stockholm region. *Int J Environ Res Public Health*. 2011;8(7): 2656-2674.
19. Feldman HA, Longcope C, Derby CA, et al. Age trends in the level of serum testosterone and other hormones in middle-aged men: longitudinal results from the Massachusetts male aging study. *J Clin Endocrinol Metab*. 2002;87(2):589-598.
20. Vingren JL, Kraemer WJ, Ratamess NA, et al. Testosterone physiology in resistance exercise and training: the up-stream regulatory elements. *Sports Med*. 2010;40(12):1037-1053.
21. Visser M, Schaap LA. Consequences of sarcopenia. *Clin Geriatr Med*. 2011;27(3):387-99.
22. Phillips SM. Physiologic and molecular bases of muscle hypertrophy and atrophy: impact of resistance exercise on human skeletal muscle (protein and exercise dose effects). *Appl Physiol Nutr Metab*. 2009;34(3):403-410.
23. Leone JE, Fetro JV. Perceptions and attitudes toward androgenic-anabolic steroid use among two age categories: a qualitative inquiry. *J Strength Cond Res*. 2007;21(2):532-527.
24. Leit RA, Pope HG Jr, Gray JJ. Cultural expectations of muscularity in men: the evolution of playgirl centerfolds. *Int J Eat Disord*. 2001;29(1):90-93.
25. Adlaf EM, Smart RG. Alcohol use, drug use, and well-being in older adults in Toronto. *Int J Addict*. 1995;30(13-14):1985-2016.
26. Graham K, Clarke D, Bois C, et al. Addictive behavior of older adults. *Addict Behav*. 1996;21(3):331-348.
27. Kanayama G, Hudson JI, Pope HG Jr. Features of men with anabolic-androgenic steroid dependence: a comparison with nondependent AAS users and with AAS nonusers. *Drug Alcohol Depend*. 2009;102(1-3):130-137.
28. Gridley DW, Hanrahan SJ. Anabolic-androgenic steroid use among male gymnasium participants: knowledge and motives. *Sports Health*. 1994;12:11-14.
29. Brower KJ, Blow FC, Young JP, et al. Symptoms and correlates of anabolic-androgenic steroid dependence. *Br J Addict*. 1991; 86(6):759-768.
30. Ricci LA, Morrison TR, Melloni RH Jr. Serotonin modulates anxiety-like behaviors during withdrawal from adolescent anabolic-androgenic steroid exposure in Syrian hamsters. *Horm Behav*. 2012;62(5):569-578.
31. McCabe SE. Comparison of web and mail surveys in collecting illicit drug use data: a randomized experiment. *J Drug Educ*. 2004;34(1):61-72.
32. Buchanan T, Smith JL. Research on the internet: validation of a world-wide web mediated personality scale. *Behav Res Methods Instrum Comput*. 1999;31(4):565-571.
33. Krantz JH, Dalal R. Validity of web-based psychological research. In: Birnbaum MH, ed. *Psychological Experiments on the Internet*. San Diego, CA: Academic Press; 2000:35-60.