Original Article

Impact of anabolic androgenic steroids on sexual function

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Background: To describe the impact of supra-physiologic anabolic-androgenic steroid (AAS) use, including agent, dosage, and duration of therapy, on sexual function.

Methods: We reviewed data from an online survey of AAS users to evaluate their sexual function on and off AAS. The online survey consisted of questions addressing demographics, anabolic steroid use and patterns, ancillary medications, testosterone (T)-related symptoms while on and off of therapy, as well as sexual function which was assessed using the 5-item, International Index of Erectile Function (IIEF-5).

Results: A total of 321 men responded to the survey, of which 90 failed to meet inclusion criteria, for a final cohort of 231 AAS users. The majority of men were Caucasian (85%), employed (62%), and younger than 35 years (58%), while an equal mix were single (47%) or married (46%). The mean IIEF-5 was 22.5, with higher scores associated with increased T dosages (>600 mg/week), use of 17-alpha alkylated hormones and anti-estrogens, and absence of concurrent medical conditions. Lower mean IIEF scores were associated with current and pre-AAS low T symptoms, self-reported angry or violent tendencies, self-reported erectile dysfunction (ED), decreased libido, decreased energy, and depression. After controlling for age, low T symptoms and decreased energy remained significantly associated with lower IIEF scores. Among 127 men reporting *de novo* decreased libido when not taking AAS, several factors were significantly associated including frequency and duration of T and use of adjunctive therapies, while post-cycle therapies were protective. Men who reported any other *de novo* symptom (decreased energy, libido, muscle mass or depression) after discontinuing T were also more likely to report *de novo* ED, as well as those using >10 years or for >40 weeks per year.

Conclusions: The long-term impact of high dose AAS use on sexual function remains poorly defined. Although high T dosages appeared to be protective of erectile function during use, *de novo* symptoms such as decreased libido and ED occurred more frequently after discontinuing T, particularly among those using more frequently and for longer durations. Given the importance of these findings, long-term studies evaluating the impacts of discontinuing T on sexual dysfunction are indicated.

Keywords: Testosterone (T); hypogonadism; International Index of Erectile Function (IIEF); erectile dysfunction (ED); libido; supplementation; body builder; weight lifter; muscle

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Introduction

Anabolic-androgenic steroids (AAS) represent a class of therapies which exhibit physical effects similar to supplemental testosterone (T). Prevalence rates for AAS use in the United States are estimated at 1–3 million, with demographics of users most commonly representing Caucasian men, aged 18–44, with advanced levels of education, above average income, and employed status (1-3).

Given their impact on augmenting physical anatomy and muscle mass, AAS have been used in an off-label manner for decades for various reasons including enhanced aesthetics, improved athletic performance, increased muscle mass, or other symptomatic benefits. T, and its downstream product dihydrotestosterone (DHT), have also been shown to have several notable physiological impacts on sexual function, including growth and development of the penis, seminal vesicles, prostate, as well as impacts on libido, arousal, and orgasm as mediated by the central nervous system (4-6).

Potential benefits of T supplementation in men with low T have been widely reported, with meta-analyses of randomized controlled trials (RCTs) demonstrating modest improvements in libido, AM erections, sexual thoughts, and erectile function (7,8). In the largest RCT to date, T supplementation in hypogonadal men resulted in mild improvements in nearly all subdomains of sexual function analyzed, with 1-year treatment effects ranging from 2–10% (9). Despite the abundance of data on the physiologic role of T on sexual function and impact of supplementation in hypogonadal men, very limited data are available on the effects of supra-physiologic AAS use on libido and erectile function in the short and long-terms.

In one of the largest studies (n=45) evaluating sexual function in men taking supraphysiologic doses of T, Moss and colleagues compared current AAS users to those previously using or non-users in a survey of amateur bodybuilding athletes. Mean age for the three groups was 25.2, 23.5, and 26.3 years, respectively, and weekly doses ranged from 75–1,550 mg/week. Results demonstrated that both current and past AAS users reported increased frequency of intercourse, with no differences in morning erections, sexual thoughts, sexual enjoyment, importance, intensity, or satisfaction. Interestingly, adverse effects in this cohort included erectile dysfunction (ED), anorgasmia, and premature ejaculation (10).

Given the known physiological role for T on sexual function and the paucity of literature reporting implications of prolonged, supraphysiologic dosing, we sought to describe sexual function in a cohort of AAS users. Specifically, we sought to evaluate if supra-physiologic T supplementation is associated with improved measures of sexual function during use and subsequent sexual dysfunctions once discontinued. To evaluate our hypothesis, a sexual function survey was performed of current and previous supraphysiologic AAS users. The objective was to identify associations between AAS use, including agent, dosage, and duration of therapy, and sexual function/dysfunctions.

Methods

Participants

After institutional review board approval, participants were recruited utilizing nine online bodybuilding forums between February 1, 2015 and June 1, 2015. A link with a short description of an anonymous survey was posted on each forum, and participants were asked to answer questions related to personal patterns of T (predominantly) and other forms of AAS use. Inclusion criteria were age ≥18 years, male gender, and a current or past history of T use.

Questionnaires

All respondents were asked to complete a questionnaire via SurveyMonkey®, a secure third-party survey tool. Participant responses were collected in an anonymous fashion, with no specific identifiers obtained.

The survey included 49-items with branching logic that were designed to elicit single-answer responses. See *Table S1* for a complete list of questions included. Participants were able to provide additional free-text information with select questions and had the option of not responding to questions.

Sexual function was assessed using the abbreviated, 5-item International Index of Erectile Function (IIEF-5), with erectile function classified as no ED [22–25], mild ED [17–21], mild to moderate ED [12–16], moderate ED [8–11], and severe ED [5–7] (11). Given the fluctuating and intermittent nature of AAS use, respondents were asked to respond to the questions based on their past six months rather than the standardized, one-month period. To evaluate adverse effects of therapy (including sexual symptoms), respondents were questioned on the presence of several known side effects while receiving and after stopping therapy.

Table 1 Demographics of current AAS users

Factor	No. (%)
Age (years)	
18–24	50 (21.6)
25–34	83 (35.9)
35–44	52 (22.5)
45–54	28 (12.1)
55–64	17 (7.4)
65+	1 (0.4)
Race/ethnicity	
Caucasian	197 (85.3)
Hispanic	14 (6.1)
Asian/Pacific Islander	6 (2.6)
African American	5 (2.2)
American Indian/Alaskan	2 (0.9)
Prefer not to answer	7 (3.0)
Employment status	
Employed	142 (61.5)
Self-employed	38 (16.5)
Student	32 (13.9)
Retired	8 (3.5)
Unemployed	6 (2.6)
Prefer not to answer	5 (2.2)
Marital status	
Single	106 (46.5)
Married	105 (46.1)
Divorced	14 (6.1)
Prefer not to answer	3 (1.3)
Missing	3

AAS, anabolic-androgenic steroid.

Demographic and historical data obtained included age, employment status, current income, level of education, and athletic participation in high school and college. Specific information on drug use included age of onset, duration and weekly dose, other performance enhancing drugs, and therapeutic cycling practices. Several T-related symptoms were assessed while on and off of therapy including libido, erectile function, fat gain, muscle loss, depression, decreased energy, loss of interest in working out, testicular shrinkage, gynecomastia, anger/violence, overconfidence, acne, and water retention. Participants were also asked about high-risk behaviors such as illicit drug use and criminal activities and further questioned on medical comorbidities and routine laboratory testing obtained. Given the length of the questionnaire, a separate analysis of the cohort and non-sexual dysfunction related responses was previously published as a separate manuscript (2).

Statistical analyses

Fisher's exact and Pearson's chi-square tests were used to compare categorical variables. Statistical significance was defined as $P \leq 0.05$, with all reported P values 2-sided. All analyses were performed using the SAS JMP (10.0; Cary, NC, USA) software package.

Results

A total of 321 men responded to the survey, of which 90 failed to meet inclusion criteria, for a final cohort of 231 AAS users. Demographic variables are presented in *Table 1*. The majority administered weekly doses of ≥600 mg/week (54%), employed some form of post-cycle therapy (56%), and used additional substances such as anti-estrogens, 17-alpha-alkylated hormones, cutting agents, or other AAS (93%). See *Table 2* for additional details on T usage patterns.

The majority of men (85%) did not initiate T due to symptoms classically associated with low T. Among those who did report low T-related symptoms, a higher percentage were older (76% ≥35 years compared to 39% of those starting T for other reasons, P<0.01), had comorbid cardiac disease (14% *vs.* 1%, P<0.01), had lower serum T levels (52% *vs.* 25%, P=0.01), and were more likely to have suffered from depression (10% *vs.* 1%, P=0.03). In contrast, those with low-T symptoms were less likely to compete in bodybuilding (0% *vs.* 10%, P=0.04), use other anabolic steroids (24% *vs.* 45%, P<0.05), obtain steroids from a friend (0% *vs.* 20%, P<0.01), or initiate T with the intent to increase muscle mass (10% *vs.* 38%, P<0.01).

A total of 222 men completed the IIEF-5 portion of the questionnaire, with a mean score of 22.5. Erectile function was further categorized as no ED (69.4%; 154/222), mild (22.1%; 49/222), mild-moderate (5.4%; 12/222), moderate (1.4%; 3/222), and severe ED (0.5%; 1/222). See *Table 2*

Table 2 Testosterone usage patterns and IIEF scores among current AAS users

Factor	No. (%)
Maximum dose/week (mg)	
<400	36 (15.6)
400–600	62 (26.8)
600–800	41 (17.7)
800–1,000	45 (19.5)
>1,000	38 (16.5)
Alt form of T	9 (3.9)
Starting age (years)	
14–18	15 (6.6)
19–22	67 (29.5)
23+	145 (63.9)
Missing	4
Duration of use (years)	
<1	51 (22.1)
1–3	90 (39.0)
3–5	33 (14.3)
5–10	28 (12.1)
>10	29 (12.6)
Weeks per year using testosterone	
<10	13 (5.7)
10–20	42 (18.3)
21–30	38 (16.5)
31–40	21 (9.1)
41–50	14 (6.1)
>50	102 (44.3)
Missing	1
IIEF scores	
Overall [mean; SD]	22.5 (3.4)
No ED [22–25], n (%)	154 (69.4)
Mild ED [17–21], n (%)	49 (22.1)
Mild-Mod ED [11–16], n (%)	12 (5.4)
Mod ED [8–11], n (%)	3 (1.4)
Severe ED [5–7], n (%)	1 (0.5)

IIEF, International Index of Erectile Function; ED, erectile dysfunction.

for IIEF scores and categorical breakdown of ED subtypes among AAS users. See *Table 3* for summary of factors associated with differences in IIEF scores.

Compared to men with more severe ED, those with mild or no ED (IIEF ≥17) were more likely to use other substances including anti-estrogens (91% *vs.* 63% among those with mild-moderate or worse ED, P<0.001), sexual enhancement medications (63% *vs.* 37%, P=0.01), 17-alpha alkylated oral hormones (62% *vs.* 33%, P<0.01), or other anabolic substances (47% *vs.* 15%, P<0.01). Men with mild or no ED also had lower rates of reduced energy after stopping T (58% *vs.* 83%, P<0.05), and use of ≤600 mg/week of T (41% *vs.* 64%, P=0.03).

When not taking T, 27% of men reported *de novo* ED, and 57% *de novo* decreased libido. Among the 127 men who reported *de novo* decreased libido when not taking AAS, several significant factors were notable including a greater frequency (>40 weeks a year of use) and duration (>3 years) of T supplementation and increased utilization of adjunctive therapies such as 17-alpha alkylated oral hormones, research pharmaceuticals, and human growth hormone. Interestingly, the use of post-cycle therapy was associated with higher rates of preserved libido when not taking T, suggesting a possible protective effect. De novo ED was also associated with various factors, including other traditional low-T symptoms, duration of T use >10 years, and use >40 weeks per year. See *Table 4* for summary of variables associated with *de novo* ED and decreased libido when not taking T.

Discussion

The current study represents the largest evaluation of sexual dysfunction in a cohort of AAS users and demonstrates several notable findings. Not surprisingly, increasing use of T was associated with higher rates of preserved erectile function in men currently using the therapy. However, surprisingly, a high percentage of men reported *de novo* sexual dysfunctions, including ED (27%) and decreased libido (57%) when not taking AAS. Additionally, longer durations of use and higher frequency of use per year were associated with experiencing these symptoms. De novo ED was also associated with multiple other classic low-T symptoms such as reduced libido, decreased energy, depression, subjective reduction in muscle mass, and increased subjective adiposity.

These findings may suggest that to some degree, the

Table 3 Factors associated with higher or lower IIEF scores

Factor	Yes (IIEF)	No (IIEF)	P value
Higher IIEF scores			
Total dose of testosterone >600 mg	23.0	21.9	0.01
17-alpha alkylated hormone use	23.1	21.7	<0.01
Anti-estrogen use	22.8	20.5	<0.001*
Use an internet supplier	23.0	22.0	0.03
Social in High School	22.8	21.8	0.03
No medical conditions	23.3	22.0	<0.01*
Do not experience side effects when off testosterone	24.0	22.3	<0.01*
Lower IIEF scores			
Any low testosterone symptoms	20.2	22.8	0.001*
Low testosterone prior to AAS	21.8	22.8	0.04
Angry or violent tendencies	20.4	22.6	0.04
Erectile dysfunction	21.1	23.1	<0.001
Decreased sex drive	22.1	23.1	0.02
Decreased energy	22.1	23.2	0.03*
Depression	21.9	22.8	<0.05

*, retains significance when controlling for age. IIEF, International Index of Erectile Function.

Table 4 Variables significantly associated with *de novo* erectile dysfunction and decreased libido after discontinuing testosterone

Factor	Decreased libido (n=127)	No decreased libido (n=94)	P
Use of post-cycle therapy	48.4%	64.9%	0.02
Average weeks/year on T (>40 weeks)	60.6%	37.2%	<0.01*
Duration of T use >3 years	48.8%	25.5%	<0.001*
17-alpha alkylated oral hormone use	66.1%	50.0%	0.02*
Research pharmaceuticals use	67.7%	50.0%	<0.01*
Human growth hormone use	30.7%	17.0%	0.03

*, retains significance when controlling for age. Rows do not add up to 100% as they represent the percentage of men in each cohort who reported the variable. ED, erectile dysfunction.

body becomes dependent upon hyper-supplementation of T (suppression of hypothalamic-pituitary-gonadal axis, possible change in androgen receptor density, possible down regulation at nuclear level), an effect that is only recognized after discontinuing. The study however is not able to address if these symptoms remain persistent for an extended period of time or whether symptoms return to baseline after a further period of recovery. These findings do support our clinical impression from our practice, in which men often do present with symptoms of sexual dysfunctions after an extended history of AAS use. Further study is required to assess this important clinical question.

As would be expected, results also demonstrated that those with increased comorbid conditions and higher rates of low T related symptoms were found to have lower IIEF scores. Similarly, those experiencing low-T symptoms when not receiving T were more likely to have moderate to severe ED, suggesting a shared mechanism for ED and other low

T symptoms.

The use of estrogen-modulating therapies were found to be a protective factor in maintaining erectile function after discontinuing AAS. Although this requires further evaluation to determine its significance, the mechanism behind commonly used selective estrogen receptor modulators, such as clomiphene citrate, includes partial estrogen receptor agonist activity. This is noteworthy, as T and estrogen have recently been shown by Finkelstein and colleagues to independently exhibit physiological effects on sexual function (12). In their study of 400 men (aged 20–50 years), each was administered Goserelin acetate to deplete gonadal steroids. Next, participants were randomly assigned to be given placebo, varying doses of topical T alone, or topical T with anastrozole (to prevent conversion of T to estradiol). Results demonstrated preservation of sexual function in men receiving T, with greater improvements noted among those not receiving anastrozole. Findings suggested that both T and estrogen have important effects on sexual function and desire, which provides a potential mechanism for outcomes of the current study.

Findings from the current study are consistent with other reported literature. In a small series of 33 prior AAS users, Rasmussen *et al.* reported similar rates of ED among former AAS abusers (27% of former AAS users compared to 29% in our cohort overall) (13). The study found that participants suffered persistent low T levels after discontinuing AAS abuse, and there were also higher rates of decreased libido and ED among former AAS abusers than participants who were currently taking the substance as well as those in the control group, all of which were also found in our larger series.

Another small study of 36 weightlifters examined the long-term effects of AAS abuse on sexual function and prolonged hypogonadism (14). Consistent with our findings, results demonstrated that former AAS abusers experienced lower sexual libido along with displaying an overall decreased testicular volume and serum T levels when compared with the weightlifters that had never used the substance. Two of the participants failed to regain erectile function or normal libido despite receiving T treatment.

The current study has several notable limitations. The data were obtained from a survey posted on body-building forums and is therefore not necessarily representative of the population as a whole. However, this was done intentionally, as data on men using high doses of AAS for extended periods of time cannot reasonably or ethically be obtained in other ways. The data are also captured at a single time point, with inability to track findings long-term and limited ability to compare findings between current and former AAS users. Despite these limitations, the current study represents the largest series of current and former AAS users with data on sexual function, utilizes a standardized IIEF questionnaire, and includes a detailed analysis of AAS frequency, duration, and dosage. This permits a more in depth and higher power analysis on factors associated with *de novo* sexual dysfunctions compared to any prior study.

Conclusions

The current study represents the largest series to date evaluating the impact of high dose, extended duration AAS supplementation on sexual function. Results demonstrate that increasing duration and frequency of AAS are associated with higher rates of *de novo* ED and decreased libido following discontinuation. Men with *de novo* ED were also more likely to report other low T symptoms, such as reduced libido, decreased energy, depression, subjective reduction in muscle mass, and increased subjective adiposity. Inversely, current use of higher T dosage and anti-estrogens (i.e., selective estrogen receptor modulators) are associated with higher current IIEF scores. Overall, findings suggest that increased frequency and duration of high-dose AAS may result in sexual dysfunctions following discontinuation and warrants further study.

Acknowledgements

None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The Committee reviewed the above referenced application and determined it to be exempt from IRB review under 45 CFR 46.101(b), item 2. Continued IRB review of this study is not required as it is currently written. However, any modifications to the study design or procedures must be submitted to the IRB to determine whether the study continues to be exempt. Review: The Committee noted receipt of the study protocol (undated). As protected health information is not being requested from subjects, HIPAA authorization is not required in accordance with 45 CFR 160.103.

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Supplementary

Table S1 Listing of questions included in the 49-item survey

Questions
1. Are you 18 years of age or older? (Excluded if “No”)
2. What is your gender? (Excluded if “Female”)
3. Do you currently or have you ever used supplemental testosterone? (Excluded if “No”)
4. What is your current age? (18 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, 65 or older)
5. What is your race? (American Indian or Alaskan native, Asian or Pacific Islander, Black/African American, Hispanic/Latino, White/Caucasian, Prefer not to answer, other)
6. Your current employment status is: (student, employed, self-employed, unemployed, retired, prefer not to answer)
7. What was your total pretax household income in 2014? (Less than $25,000, $25,000 to $34,999, $35,000 to $49,999, $50,000 to $74,999, $75,000 to $99,999, $100,000 to $149,999, $150,000 or more, Prefer not to answer)
8. What is the highest level of education you have completed? [12th grade or less (no diploma), high school diploma, some college, no degree, associate or technical degree, bachelor's degree, graduate degree/professional, prefer not to answer, other]
9. What is your marital status? [Single (never married), Married, Separated, Widowed, Divorced, Prefer not to answer]
10. Do you have siblings?
11. Please input the number of older and younger siblings, including brothers and sisters.
12. Did you play sports in high school?
13. Did you play sports at the collegiate level?
14. Please choose the answer that most describes you. (I would describe myself as social in high school, I was involved in other extracurricular activities besides sports in high school—strongly disagree, disagree, agree, strongly agree)
15. At what age did you start using testosterone? (14, 14–18, 19–22, 23+)
16. Why did you start taking testosterone? [Free text; subsequently categorized into following: attract women, anti-aging, peer pressure, break exercise plateau, enhance sporting performance, compete in bodybuilding/powerlifting, low testosterone symptoms (erectile dysfunction, or reduced libido, energy, or motivation), depression, low testosterone measurement, enhance strength, difficulty gaining muscle, improve muscle mass, aesthetics, endurance, improve life overall]
17. How long have you been using supplemental testosterone (years)? (<1, 1–3, 3–5, 5–10, >10)
18. On average how many weeks per year are you on testosterone? (<10, 10–20, 21–30, 31–40, 41–50, >50)
19. What is the highest testosterone dose you have used (mg/week)? (<400, 400–600, 600–800, 800–1,000, >1,000)
20. What other PEDs have you used? (Check all that apply) [Antiestrogens, research pharmaceuticals (without prescription) for sexual enhancement, human growth hormone, 17-alpha alkylated (methylated) oral hormones, research peptides, cutting agents, please list other anabolic steroids you have used]
21. Do you use any form of PCT?
22. Where do you obtain your supplemental testosterone? [Antiaging clinic, internet supplier, doctor, personal friend, overseas pharmacy, other (please specify)]
23. How much do you spend on testosterone and other PEDs per month (on average)? (<$100, $100–500, $501–1,000, $1,001–1,500, >$1,501)
24. Do you see a doctor regularly?
25. Do you have any medical conditions? [High blood pressure, hypogonadism (prior to PEDs usage), hypogonadism (post PEDs usage), diabetes, kidney disease, obesity, heart disease, liver disease, psychiatric diagnosis, none, other (please specify)]
26. Have you ever had kidney or liver injury from testosterone usage?
27. Do you have any blood tests checked while using testosterone?
28. Have you ever had any lab abnormalities?
29. Do you notice any side effects while on testosterone? [Acne, water retention, painful nipples, testicular shrinkage, fatigue, angry or violent tendencies, depression, over confidence, none, other (please specify)]
30. Do you notice any side effects when not taking testosterone? [Erectile dysfunction, decreased sex drive, decreased energy, depression, loss of muscle, fat gain, loss of interest in working out , none, other (please specify)]
31. Have you attempted to have children?
32. How long did it take your partner to become pregnant?
33. Have you had any difficulty achieving a pregnancy?
34. Have you ever visited with a fertility specialist?
35. Have you required fertility assistance with medications or surgery?
36. Were you on testosterone while attempting to get your partner pregnant?
37. How many children have you had?
38. How do you rate your confidence that you could get and keep an erection?
39. When you had erections with sexual stimulation, how often were your erections hard enough for penetration?
40. During sexual intercourse, how often were you able to maintain your erection after you had penetrated your partner?
41. During sexual intercourse, how difficult was it to maintain your erection to completion of intercourse?
42. When you attempted sexual intercourse, how often was it satisfactory for you?
43. Have you used any other illegal substances?
44. Did you use these before or after you started taking testosterone?
45. Have you pled no contest to or been convicted of a crime?
46. Did your legal issues occur before or after you started taking testosterone?
47. What is the highest degree of crime that you have been convicted of? (Infraction, misdemeanor, felony)
48. Do you personally know anybody who has been harmed by testosterone or other performance enhancing drugs?
49. Do you feel using testosterone in a tested sport is unfair?

PED, performance enhancing drug; PCT, post-cycle therapy.