British Journal of Addiction (1991) 86, 759–768

RESEARCH REPORT

Symptoms and correlates of anabolic-androgenic steroid dependence

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Abstract

Forty-nine male weight lifters, all users of anabolic-androgenic steroids (AASs), completed an anonymous, self-administered questionnaire to investigate addictive patterns of use. At least one DSM-III-R symptom of dependence was reported by 94% of the sample. Three or more symptoms, consistent with a diagnosis of dependence, were reported by 57%. Dependent users (n=28) could be distinguished from non-dependent users (n=21) by their use of larger doses, more cycles of use, more dissatisfaction with body size, and more aggressive symptoms. Multiple regression analysis revealed that dosage and dissatisfaction with body size were the best predictors of dependent use. Patterns of other substances used, although not predictive of AAS dependence, revealed very low cigarette use and at the same time high alcohol consumption. These data support the notion that AASs are addicting, and suggest that dissatisfaction with body size may lead to dependent patterns of use. The implications for both prevention and treatment are discussed.

Introduction

Anabolic-androgenic steroids (AASs), which include the male hormone, testosterone, and its synthetic derivatives, are used illicitly to enhance athletic performance, physical appearance, and fighting ability.[1,2] Several studies suggest that the use of AASs is associated with psychiatric symptoms, such as increased aggression and mood disturbances.[3–6] Other reports suggest that AASs have addictive potential.[7–10] The potential of AASs to cause addiction and other psychiatric effects implies that mental health and addiction professionals may increasingly see AAS users in practice.

We previously reported results of a pilot survey,[4] in which all eight AAS users had experienced symptoms of psychoactive substance dependence as defined by DSM-III-R.[11] We now extend our findings to 49 male AAS users. Specifically, the objectives of the present study were to describe a community-based sample of male weight lifters who admitted to taking AASs in terms of demographics, training characteristics, and patterns of AAS use; to determine the nature and frequency of dependency symptoms in the sample; and to determine if there were particular demographic, pharmacologic, or psychological correlates of dependence on AASs.

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Methods

Subjects

Subjects were 49 male weight lifters who were recruited from four community gymnasiums to complete a self-administered questionnaire. In-

formed consent was obtained in writing from the gym owners or managers to distribute the questionnaire on-site. Owners/managers were assured that the name of their gym and other identifying information would be kept confidential. Four gymnasiums were selected because of their convenience, and none refused participation.

Over a 7-month period ending in November 1989, 449 questionnaires were collected from weight lifters, including 45 females (10%). Because only two female AAS users were identified, we excluded women from the analyses. Of the 404 surveys from men, 49 (12%) admitted to using AASs and comprised the sample for this study.

The questionnaire

We developed a questionnaire specifically for this study, entitled "The University of Michigan Weight Lifter's Survey". Designed to be self-administered in 15–20 minutes, it obtained information about demographic variables, training characteristics, physical characteristics, body image, AAS and other substance use, and consequences of AAS-taking. Questions regarding symptoms of dependence on AASs were modified from two existing structured diagnostic instruments that are keyed to DSM-III-R criteria.[12,13]

Subjects were asked by research assistants to complete the questionnaire either before or after their workouts. The front page contained instructions that explained the purpose of the questionnaire and gave assurance about anonymity. Subjects were instructed not to put their names on the questionnaire. They placed the completed questionnaire inside a provided envelope, sealed it, and deposited it in a specially designated box. The questionnaires were then removed from the gym and opened at a later date by research staff, who did not know from which gymnasium they came or who filled them out.

The validity of the questionnaire was tested in a pilot sample by face-to-face interviews in five subjects and urine testing in one subject. In all tested instances, the information on the questionnaire was confirmed. In addition, reliability coefficients for two repeated questions in the questionnaire among the 49 subjects were high (Pearson $r=0.98$, $p=0.0001$ and $r=0.83$, $p=0.0001$).

Variables of interest

We were first interested in describing our sample in terms of demographics, training characteristics, and patterns of AAS use. We were next concerned with the type and frequency of DSM-III-R symptoms of dependence that were reported. To examine dependence as a syndrome, we divided our sample into two groups. Those who endorsed three or more DSM-III-R symptoms of dependence were classified as dependent, in accordance with the DSM-III-R criteria for the diagnosis of dependence.[11] Those who endorsed less than three symptoms were classified as non-dependent. We then compared these two groups on variables that we thought might either predict or correlate with dependence. These variables could be classified into four major domains: demographic, pharmacologic, psychological, and physical.

Most variables are self-explanatory, except for those that follow. Among pharmacologic variables, duration of AAS use was calculated as the number of months between first and last use. Because different individuals used different AASs with differing potencies, a derived measure was created to compare dosage across individuals. The mean dose across individuals using a particular drug was calculated, and each individual's dosage of that drug was then converted to a standardized z-score. The individual's highest z-score among all drugs tried was used as the measure of maximum dosage. The four CAGE screening questions for alcoholism were included, in which a score of 2-4 is considered a positive screen.[14]

Psychological variables included the number of reported psychological benefits (range 0–6) from taking AASs (really felt good, felt 'high' or extreme pleasure, felt more confident, felt more aggressive, improved sex life, attracted new sex partners), the degree of satisfaction with one's body and physical appearance before and after using AASs, and the degree of feeling 'not big enough' before and after using AASs. The following adverse effects were also studied: presence of psychotic symptoms (saw things or heard voices that were not really there; believed things were happening that really were not) and the number of aggressive symptoms (range 0–4) (more aggressive, more irritable, more angry outbursts, and more violent confrontations). Because aggression is sometimes considered a benefit and sometimes a side effect by AAS users, the questionnaire listed this effect under both categories.

Finally, the following physical variables were assessed: the number of reported physical benefits (range 0–6) from taking AASs (increased muscle strength, increased muscle size, increased endurance during workouts, increased performances during

competition, competed with better athletes than before, improved recovery time after injury); the difference in body weight before and after using AASs; and the increase in the maximum amount of weight lifted before and after using AASs for both the bench press (upper extremity strength) and the squat (lower extremity strength). The total number (range 0–19) of adverse side effects was also compared, including 11 physical effects (musculoskeletal injuries, testicular atrophy, gynecomastia, insomnia, acne, edema, hirsutism, alopecia, jaundice, liver disease, hypertension) and eight psychological ones (more aggressive, more irritable, more angry outbursts, more violent confrontations, hallucinations, delusions, increased or decreased libido).

Data analysis

Our primary interest was in predicting dependence using a multiple regression analysis. As preliminary steps, we conducted univariate analyses, both for descriptive purposes and to eliminate variables from the multiple regression analysis.

Primarily for descriptive purposes, we compared the dependent and non-dependent groups of subjects in terms of the four major domains of variables (Table 4). For these comparisons, t tests were applied for continuous variables. Dichotomous variables were tested with either the chi-square test or the Fisher's exact test if cell sizes were too small. Ordinal variables were tested with the Wilcoxon two-sample test. All tests were two-tailed. Nominal significance levels were determined and presented. The experiment-wise significance levels (Bonferroni corrections) were calculated, based on the number of comparisons within each domain of variables, and are mentioned in the results where they were important.

Because severity of drug dependence may be considered a continuum and because the DSM-III-R's threshold value of three symptoms for dependence is somewhat arbitrary, we used the number of positive DSM-III-R criteria for each subject as our next variable of interest. Correlation tests were performed between the number of dependency symptoms and other variables, using Pearson r and Spearman (r_s) rank-order correlations for continuous and ordinal variables, respectively.

Finally, we employed stepwise, multiple regression techniques to evaluate the simultaneous impact of the independent variables on the number of positive criteria for drug dependence. The correlations previously described were utilized to reduce the number of variables considered for the regression model. Those variables that suggested a potential association ($p<0.10$) were entered into the multiple regression analysis.

Results

Characteristics of the sample

In general, subjects were young, single, white men who were employed and had completed over 2 years of college (Table 1). Subjects had been lifting weights for a mean of 88.1 (±52.3) months and spent a mean of 10.6 (±3.9) hours each week lifting weights. Their most commonly cited reasons for lifting weights were to improve physical appearance (96%), to improve physical condition (92%), for personal enjoyment (92%), and to increase self-esteem (89%). By contrast, only 57% of the sample were lifting weights to train for sporting events and only 44% were specifically training for bodybuilding competition (Table 1). One-fifth (19.6%) of the sample denied training for either bodybuilding competition or other sports.

Table 1. *Sample characteristics* (n=49)

Demographics	
Age (years)*	24.4±5.7
Percent white	92
Education (years)*	14.5±2.2
Percent employed	78
Yearly income (dollars)*	19,461±14,781
Percent never married	77
Reasons for lifting weights† (%)	
To improve physical appearance	96
To improve physical condition	92
For personal enjoyment	92
To increase self-esteem	89
To increase energy level	78
To attract sexual partners	63
To train for sports	57
Bodybuilding competition	44

* Mean±SD.

† Subjects could endorse more than one reason.

Subjects began using AASs at a mean age of 21.2 (±4.3) years, and had been lifting weights for a mean of 4.0 (±3.0) years before initiating AASs. The mean interval (duration) between first and last use of AASs was 20.9 (±25.2) months. Sixty-one (60.9%) percent of the sample used both injectable and oral AASs, while 19.6% each used either injectable or oral agents exclusively. Thus, approximately 80% had injected AASs, but all subjects denied sharing needles. A pattern of use character-

Table 2. *Ten most commonly used anabolic-androgenic steroids by sample (n=49)*

Rank	Generic name	Trade name*	% who used	Mean ± SD dose (MD) (mg/wk)	Therapeutic dose (TD)† (mg/wk)	MD/TD
1	Methandrostenolone	Dianabol	55.1	210.4 ± 166.2	35.0	6.0
2	Nandrolone decanoate§	Deca-Durabolin Anabol LA	44.9	565.7 ± 1159.8	21.4	26.4
3	Oxandrolone	Anavar	34.7	172.0 ± 110.3	52.5	3.3
4	Testosterone cypionate§	Depo-Testosterone	30.6	814.7 ± 1401	75.0	10.9
5	Oxymetholone	Anadrol-50	20.4	9.4 ± 4.0‡	3.0‡	3.1
6	Boldenone undecylenate§	Equipoise	18.4	214.3 ± 69.0	-||	-
7	Stanozolol injection§	Winstrol-V	16.3	346.9 ± 439.2	-||	-
8	Trenbolone§	Finaject 30	12.2	96.0 ± 53.7	-||	-
9	Testosterone enanthate§	Delatestryl	10.2	400.0 ± 163.3	75.0	5.3
9	Nandrolone phenpropionate§	Durabolin	10.2	66.7 ± 28.9	37.5	1.8

* Representative trade names, not necessarily taken by subjects.
† See text for method of estimation.
‡ Units for oxymetholone only are mg/kg/wk.
§ Injectable drug form. Finaject 30 might also signify bolasterone to some users.
|| Veterinary drug for which human dosage is unknown.

ized by 'cycling' (periods of use followed by periods of no use) was practiced by 73.5% of the sample. The most commonly used AASs by our sample are listed in Table 2. The mean weekly doses used for each of the AASs are compared to 'average' therapeutic doses, defined as the mathematical mean of the range of therapeutic doses as cited in an authoritative textbook of pharmacology.[15] (For example, the therapeutic dosage range for testosterone cypionate is 50–400 mg every 2–4 weeks.[15] The mathematical mean is 225 mg every 3 weeks or 75 mg per week.) Subjects exceeded therapeutic dosages for each of the commonly used AASs by 2- to 26-fold. Because subjects combined or 'stacked' a mean of 2.6 (±1.2) AASs at one time, individual subjects may have exceeded therapeutic dosages by even more.

Symptoms of dependence

All nine DSM-III-R criterion symptoms for dependence were reported (Table 3). The mean number of DSM-III-R symptoms of dependence reported was 2.8 (±1.6). At least one symptom of dependence was reported by 94% of the sample. Three or more symptoms, consistent with a DSM-III-R diagnosis of dependence, were reported by 28 (57%) of the subjects. Four (8.2%) of the subjects endorsed six or more symptoms and, thus, might be classified with severe dependence as described in DSM-III-R.

Withdrawal was the most commonly reported symptom of dependence (84%). The most frequently reported withdrawal symptoms were depressive in nature: fatigue (43%), depressed mood (41%), restlessness (29%), anorexia (24%), insomnia (20%), and decreased libido (20%). Other frequently reported symptoms during withdrawal were: a desire to take more AASs (52%), dissatisfaction with body image (42%), and headaches (20%). Suicidal thoughts were reported by 4% of the group during the withdrawal period.

Correlates of dependence

Of the 49 AAS users, 28 were classified as dependent (≥3 positive DSM-III-R criteria) and the remaining 21 were non-dependent. Analyses demonstrated that these groups did not differ significantly with respect to age, age at first use, race, education, income, employment status, or marital status.

Table 4 presents the comparisons between the dependent and non-dependent groups for the pharmacological, psychological, and physical variables. Suggestive differences (nominal $p<0.05$) were seen

Table 3. *Self-reported symptoms of dependence* (n=49)*

DSM-III-R criterion symptom		Number	%
(1)	More substance taken than intended	25	51
(2)	Desire yet unable to cut down or control use	8	16
(3)	Large time expenditure on substance-related activity	19	40
(4)	Frequent intoxication or withdrawal symptoms when expected to function or when physically hazardous	4	9
(5)	Social, work, or leisure activities replaced by AAS use	14	29
(6)	Continued AAS use despite problems caused or worsened by use	18	37
(7)	Tolerance	9	18
(8)	Withdrawal symptoms	41	84
(9)	Substance used to relieve or avoid withdrawal symptoms	2	4

* Group size was smaller for some symptoms due to incomplete responses.

for maximum dosage, number of cycles, not feeling big enough after using AASs, and number of aggressive symptoms. As might be expected, dependent users took larger doses of AASs, completed more cycles of use, and reported more aggressive symptoms. An unexpected finding was that they continued to feel not big enough after using AASs ($p<0.0063$ after Bonferroni correction). With respect to other substances, there were consistent, albeit statistically insignificant, trends for the dependent users to drink, smoke, and use stimulants more (Table 4). Both groups of AAS users had relatively high rates of alcoholic drinking as determined by positive CAGE scores, yet extremely low levels of cigarette consumption. There was a non-significant trend for more dependent users to report feeling 'high' on AASs (50 vs 33%).

The correlations between the number of dependency symptoms and the predictor variables are presented in Table 5. Using an alpha level of 0.10 for entry into the linear regression analysis, the following variables were selected: number of AASs tried, maximum dosage, CAGE score, feeling not big enough before AASs, feeling not big enough now, dissatisfied with appearance before AASs, number of aggressive symptoms, difference in body weight, difference in the amount of weight lifted by the bench press method (an exercise of upper extremity strength), and number of adverse side effects. Although the number of cycles was very highly correlated with the number of dependency symptoms, there were 30 missing responses because the question was omitted from the original version of the questionnaire. Therefore, this variable was not used in the subsequent analysis.

Using stepwise techniques, we arrived at the model presented in Table 6. The significant predictors of the number of dependency symptoms were maximum dosage of AASs taken and feeling not big enough after taking AASs. The model implies that as the maximum dosage increases by 1 SD, the number of dependency symptoms increases by 0.54, given that the response to feeling not big enough remains constant. Likewise, the change from never to sometimes feeling not big enough, or from sometimes to always feeling not big enough, predicts an average of 1.6 more symptoms of dependence, given that the dosage remains constant.

Discussion

Several other studies have described AAS users who, similar to our sample, were either all or predominantly male,[5,6,16–20] were relatively young,[5,6,16,18–20] used higher than therapeutic does,[6,17,18], combined or 'stacked' multiple AASs,[5,6,17,21], 'cycled',[5,17,21] used veterinary preparations,[5,6,20] and had high rates of alcohol abuse.[5] Furthermore, our list and ranking of the most commonly used AASs (Table 2) are nearly identical to those reported recently by two other independent research teams in different geographical locations.[5,20] Also, the time lag between initiating weight lifting and starting to use AASs was 4–6 years in another recent study,[20] compared to a mean of 4.0 years in our sample. Finally, our subjects, similar to others,[5,18,19] reported getting bigger and stronger after using AASs. Although the physical gains reported by our subjects were not objectively verified, and although the true efficacy

Table 4. *Comparison of dependent and non-dependent steroid users**

Variable	Non-dependent ($n=21$)†	Dependent ($n=28$)†	Significance	
Pharmacologic				
Number of AASs tried	2.0 ± 2.1	2.8 ± 2.6	NS	
Number of AASs combined	2.5 ± 1.2	2.8 ± 1.3	NS	
Duration of use (months)	20.7 ± 28.9	21.1 ± 22.4	NS	
Number of 'cycles' (episodes of use)	2.1 ± 1.0	4.1 ± 2.4	0.028	
Length of cycles (weeks)	8.4 ± 4.4	13.1 ± 15.6	NS	
Injectables used (%)	71.4	88.0	NS	‡
Maximum dosage (z-score)	0.0 ± 1.2	1.0 ± 1.0	0.016	
Other performance aids tried (no.)	5.2 ± 2.8	6.1 ± 1.9	NS	
Cocaine/amphetamine use (%)	0.0	14.3	NS	‡
Cigarette use (pack-years)	0.0 ± 0.0	0.1 ± 0.6	NS	
Max drinks/day in last 30 days	8.1 ± 7.3	10.0 ± 8.4	NS	
CAGE score positive (≥2) (%)	21.1	37.0	NS	
Psychological				
Psychological benefits (0–6)	2.4 ± 1.6	2.5 ± 1.3	NS	
Felt 'high' on steroids (%)	33.3	50.0	NS	
Satisfied with appearance before‖	2	2	NS	§
Satisfied with appearance after‖	3	2	NS	§
Felt not big enough before¶	3	4	NS	§
Feels not big enough now¶	3	4	0.002	§
Psychotic symptoms reported (%)	4.8	14.3	NS	‡
Number of aggressive symptoms (0–4)	2.1 ± 1.5	3.1 ± 1.3	0.020	
Physical				
Physical benefits (0–6)	4.8 ± 1.1	4.7 ± 1.1	NS	
Weight difference (lb)	19.8 ± 28.2	28.3 ± 19.2	NS	
Bench press difference (lb)	53.1 ± 42.1	80.6 ± 55.0	NS	
Squat difference (lb)	108.6 ± 92.6	127.3 ± 93.9	NS	
Number of adverse side effects	5.7 ± 4.4	7.5 ± 3.6	NS	

* Continuous variables are expressed as means (±SD) and compared by Student's t-tests; dichotomous variables are expressed as percent positive and compared by chi-square tests unless otherwise specified.
† Group sizes are smaller for some variables due to incomplete responses.
‡ Fisher's exact test (two-tailed) was used because of small cell sizes.
§ Wilcoxon two-sample tests were used for median scores.
‖ Median score (before or after steroids) on a scale of 1–4 with 1 signifying least satisfaction.
¶ Median score (before or after steroids) on a scale of 1–5 with 1 signifying never feeling not big enough and 5 signifying feeling not big enough all of the time.

of AASs in producing these desired effects remains controversial,[1] the perception of users that these drugs work must be taken into account by any program of prevention or treatment.

Symptoms of dependence, based on DSM-III-R criteria, were commonly reported. At least one symptom of dependence was reported by 94% of the sample; and three or more symptoms, consistent with a DSM-III-R diagnosis of dependence, were reported by 57%. All dimensions of the dependency syndrome, including symptoms of both psychological dependence (symptoms 1–6) and physical dependence (symptoms 7–9), were reported with the use of AASs (Table 3).

The discrepancy between the high frequency of withdrawal symptoms (84%) and the low use of AASs to relieve withdrawal symptoms (4%) requires explanation. The discrepancy may be attributable to the way the questions were asked. After a checklist of various withdrawal symptoms, subjects were asked, "Have you often used steroids to keep yourself from getting sick or have you often used steroids when you were feeling sick so that you would feel better?" The wording for this question is nearly identical to the corresponding question in the Structured Clinical Interview for DSM-III-R.[13] Nevertheless, had the question referred directly back to the list of withdrawal symptoms, the frequency of positive responses may have been higher.

Table 5. *Correlations between number of dependency symptoms and other variables*

Variable	Correlation coefficient*	*p* value
Pharmacologic		
Number of AASs tried	+0.25	0.085§
Number of AASs combined	+0.08	0.601
Maximum dosage (*z*-score)	+0.33	0.052§
Number of 'cycles' (episodes of use)	+0.59	0.007‡
Length of cycles	+0.03	0.863
Duration of use	+0.10	0.512
Other performance aids tried	+0.13	0.378
Maximum drinks/day in last 30 days	−0.04	0.762
Cigarettes (pack-years)	+0.19	0.203
CAGE score	+0.27†	0.073§
Psychological		
Psychological benefits	+0.11†	0.459
Aggressive symptoms	+0.32†	0.026‡
Not big enough before	+0.38†	0.010‡
Not big enough now	+0.50†	0.001‡
Appearance—satisfied before	−0.28†	0.070§
Appearance—satisfied now	−0.19†	0.216
Physical		
Physical benefits	−0.12†	0.410
Weight difference	+0.28	0.051§
Bench press difference	+0.27	0.065§
Squat difference	+0.11	0.521
Side effects	+0.29	0.043‡
Demographics		
Age	−0.20	0.172
Age at first use	−0.15	0.318
Education	−0.05	0.778
Income	−0.12	0.443

* Pearson *r* correlations are presented except where noted otherwise.
† Spearman rank-order correlation coefficient (r_s).
‡ $p<0.05$ which is considered a significant correlation.
§ $p<0.10$ which qualified variable for multiple regression analysis.

Table 6. *Model for predicting the number of dependency symptoms.*

Omnibus $F=5.54$; $p=0.0094$; $n=31$; $r^2=0.28$

Variable	Parameter	SE	*F*	*p*-value
Intercept	0.036	1.003	0.00	0.972
Maximum dosage	0.542	0.240	5.11	0.032
Feels not big enough now	0.787	0.295	7.12	0.012

When comparisons were made between dependent ($n=28$) and non-dependent ($n=21$) users, only pharmacologic and psychological variables were nominally significant. As might be expected, dependent users had taken larger doses of AASs and had completed more cycles of use. They also were more likely to feel not big enough, and they reported more aggressive symptoms (Table 4). Interestingly, the number of aggressive symptoms did not correlate with the maximum dose ($r_s=0.054, p=0.76$) or with any other pharmacological variables, including other substance use (data not shown). Although the severity of aggressive symptoms was not assessed and may have been dose-related, these data raise the possibility that non-pharmacological factors (such as an underlying psychological vulnerability) may predispose steroid users to aggressivity with AASs. Clinically, dependence on AASs should be sus-

pected in users who manifest aggressive symptoms or who persist in AAS-taking despite aggressive problems.

In the multiple regression analysis, larger doses and feeling not big enough were predictors of dependence. These findings are consistent with a model we have proposed previously.[2] In that model, we postulated that progression from initial use of AASs to dependent use of AASs was likely to be influenced by pharmacological, psychiatric, and genetic factors. Of particular interest is the finding that dependent users did not feel big enough despite their reports of getting physically bigger on AASs. Thus, body size dissatisfaction may represent a psychological vulnerability that predisposes AAS-takers to dependence. The situation may be somewhat analogous, although in reverse fashion, to patients with anorexia nervosa, who persistently employ (or are 'dependent' on) dieting and other weight-loss measures because they do not feel small enough despite getting physically smaller. Moreover, preliminary data from our steroid non-users revealed greater dissatisfaction with body size among the non-users who were thinking about using AASs, compared to non-users who were not thinking about using.[22] One clinical implication is that attention to body image may be crucial for both prevention and treatment efforts with respect to AASs.

Two pertinent variables, having no significant correlations with dependency symptoms, were age at first use and other substance use. Age at first use has been shown to be an important predictor of problematic use of alcohol and other drugs.[23] Similarly, Yesalis *et al.*[24] found that senior high school students who began using AASs before the age of 16 years were more likely to manifest symptoms of 'psychological dependence'. The lack of a correlation in this study may relate to the small variance in our sample for age at first use. With respect to other substances, our sample had a high rate of alcoholic drinking, similar to the finding by Perry *et al.*[5] in their diagnostic study of both steroid-using and non-using weight lifters. The sharp contrast between high alcohol consumption and low cigarette use in our sample is an interesting pattern, because in most other instances cigarette and alcohol consumption are highly correlated with each other.[25] The way in which alcohol, cigarettes, and AASs are differentially viewed by this group may provide a key for influencing the use (or lack of use) of AASs among weight lifters. Apparently, weight lifters have values and beliefs that discourage cigarette smoking. One can speculate on the nature of these beliefs, such as "smoking will impair my athletic performance", "smoking will detract from my physical appearance", "smoking will cause me physical harm" or "smoking cigarettes is addicting". To the extent that research both confirms that weight lifters have these beliefs and provides evidence that these are appropriate beliefs to have about AASs as well, then research-based education might help to deter steroid-taking. Indeed, existing research already provides some evidence that taking AASs may (1) increase tendon injuries which could impair athletic performance,[26] (2) detract from physical appearance by causing unsightly acne and gynecomastia,[1,26] (3) cause physical harm,[1,26] and (4) lead to addiction.[4,7–10] Nevertheless, in contrast to tobacco smoking, epidemiological studies of the long-term health consequences of using AASs are completely lacking.[27] In the absence of such studies, prevention programs must be careful to avoid using scare tactics that will lack credibility to potential users. In any case, the relationship between AAS dependence and other substance dependence warrants further study.

Some authors have speculated that AASs may affect either endogenous opioid or monoaminergic systems in the brain to produce dependence.[2,9,10] Although we did not study neurotransmitter systems, drug-induced euphoria may be an indirect measure of neurotransmitter-mediated reinforcement. One-half of the dependent users reported feeling high or extreme pleasure on AASs (Table 4), suggesting that AASs can reinforce self-administration in part by euphorigenic properties. Nevertheless, the other half did not report euphoria, and euphoria did not correlate with dependence.

Other authors have suggested that AAS dependence develops in response to the social reinforcement and pleasure from having a big muscular body.[24] Although we did not inquire about social reinforcement *per se*, neither psychological benefits (including the ability to attract new sexual partners and improved sex life) nor physical benefits correlated with dependence. Indeed, dependent users were more likely to express dissatisfaction rather than pleasure with their bodies. In short, our data suggest that addiction to AASs is driven more by negative reinforcement (trying to avoid feeling not big) than by positive reinforcement (psychological and physical benefits).

There are several methodological limitations to this study. First is the issue of selection bias. We relied on convenience to recruit subjects from a

small number of gyms, which were located within a relatively restricted geographic region. Thus, we do not know how representative our sample was of other AAS users, particularly women. Moreover, we can make no generalizable prevalence statements regarding AAS dependence. We do believe, however, that the study demonstrates that dependence on AASs occurs commonly enough to be readily detectable with the methods we employed. The fact that our sample was drawn from the community, rather than from a treatment setting, makes the high prevalence of dependence in this study all the more striking.

A second limitation is the lack of methods to corroborate self-report, such as direct interviews, physical measurements, or urine testing. We did pilot the instrument as previously described and included internal reliability measures. In addition, the use of anonymous self-report may have facilitated truthful responding. Nevertheless, the findings of this study should be confirmed by similar studies in which corroborating information is obtained. Finally, there were a number of potentially pertinent variables that were not explored here. Future studies should include genetic or familial factors, such as a family history of substance abuse, and predisposing psychopathology such as sociopathy or depression. Such studies should also more clearly define the variable of 'feeling not big enough', which could refer to weight, muscularity, and/or height. Future research could also employ a prospective design, in which a larger cohort of AAS-using initiates are followed over time, until a proportion of them become dependent.

Conclusions

The full spectrum of dependency symptoms was reported by our sample of AAS users. The knowledge that the use of AASs can lead to dependence may discourage some at-risk individuals from initiating use. Thus, this information may have value to those involved in prevention efforts. Prevention programs might also benefit by research into the reasons for the dissociation we found between heavy alcohol and minimal tobacco use. If confirmed by other studies, then the protective factors against smoking among AAS users might be 'harnessed' in the service of preventing AAS use and heavy alcohol consumption among this population. Dependent users reported more symptoms of aggression than non-dependent users, underscoring the clinical importance of diagnosing and treating dependence among aggressive AAS users. Moreover, the number of aggressive symptoms did not correlate with dosage or other pharmacological variables, suggesting that a non-pharmacological factor (such as a psychological vulnerability) may predispose AAS users to aggressiveness. Finally, the best predictors of dependence were dosage and dissatisfaction with body size. Both prevention and treatment programs, therefore, may need to target body image in order to be optimally effective.

Acknowledgements

The authors wish to acknowledge the contributions of Drs. George A. Eliopulos, Thomas P. Beresford and Frederick B. Glaser. This work was supported in part by grant AA07378 from the National Institute on Alcohol Abuse and Alcoholism.

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