J Forensic Sci, May 2003, Vol. 48, No. 3
Paper ID JFS2002240_483
Available online at: www.astm.org

Paul J. Perry,[1,2] *Ph.D.; Eric C. Kutscher,*[1] *Pharm.D.; Brian C. Lund,*[1] *Pharm.D.; William R. Yates,*[3] *M.D.; Timothy L. Holman,*[1] *M.A.; and Laurence Demers,*[4] *Ph.D.*

Measures of Aggression and Mood Changes in Male Weightlifters With and Without Androgenic Anabolic Steroid Use

ABSTRACT: Supraphysiologic doses of testosterone are associated with increased aggression that is hypothesized to be a function of testosterone serum concentrations, mood, and personality. The study attempted to characterize this relationship among weightlifters who were users ($n = 10$) and nonusers ($n = 18$) of anabolic steroids. Participants were interviewed using the Modified Mania Rating Scale and Hamilton Rating Scale for Depression to assess mood, the Buss-*Durkee* Hostility Inventory (BDHI) and Point Subtraction Aggression Paradigm (PSAP) to assess aggression, and the Personality Disorder Questionnaire (PDQ-R) to assess personality. Blood samples were obtained for the determination of total, free, and weakly bound testosterone. Comparisons of continuous variables between testosterone users and non-users were performed with a parametric (unpaired t-test) or non-parametric (Mann-Whitney) test where appropriate. Correlations with testosterone were examined separately for testosterone users and non-users, using Spearman rank correlation. The subjective (BDHI) and objective (PSAP) assessments of aggression found that supranormal testosterone concentrations were associated with increased aggression. However, the PDQ-R results suggest that this finding was confounded by the personality disorder profile of the steroid users, because steroid users demonstrated Cluster B personality disorder traits for antisocial, borderline, and histrionic personality disorder.

KEYWORDS: forensic science, testosterone, aggression, mood, personality disorder

Aggressive behavior and mood changes have been linked to anabolic steroid (AS) use in case reports (1,2). Although these reports describe increases in aggression and violent behavior with AS use, there are relatively few controlled studies relating aggressive behavior and mood changes to AS use in weightlifters.

Seven randomized controlled studies have measured psychiatric changes associated with the administration of supraphysiologic doses of testosterone to "normal" male participants (3–9). These studies indicate limited risk of mental status changes with IM testosterone doses as high as 600 mg/week. With larger doses, however, changes in various mood and aggression subscales have been observed. Pope and colleagues described significant increases in the Point Subtraction Aggression Paradigm (PSAP) and the Young Mania Rating Scale (YMRS) among higher testosterone doses (600 mg/week) compared to placebo. While group differences were observed, the distribution of individual scores was also important (9). Specifically, 42 subjects receiving testosterone had minimal psychiatric symptoms at endpoint (YMRS < 10), six had moderate scores (YMRS of 10 to 19), and two had marked scores (YMRS ≥ 20). In contrast, only one of 49 subjects receiving a placebo had a moderate or marked YMRS score at endpoint (9). Although Pope was able to demonstrate significant alterations in overall aggression and mood endpoints, the majority of subjects did not experience significant aggressive symptoms (9). However, these studies do support variation among individuals susceptible to changes in mood and aggression (3–5,7,8).

While these studies are not conclusive, they suggest that AS use promotes aggression and mood changes among certain individuals, although there are several limitations that need to be considered. First, many of the above studies did not enroll weightlifters as subjects (3–5,7,8). The study of "normal healthy males" may not be representative of typical users of AS in the general population such as weightlifters and other athletes. The second limitation is the exclusion of subjects with premorbid psychiatric disorders, particularly personality disorders. Such individuals may be more susceptible to AS-induced psychiatric changes than normal control subjects. The third limitation is that the AS regimens were limited to a single agent administered weekly at doses $\leq$ 600 mg/week (3–5,7,9). These regimens do not represent the multi-drug combinations (stacks) illicitly used by athletes. Furthermore, the maximum dose given in clinical trials was 600 mg/week for two weeks (5,9), which is anecdotally considered to be below the doses commonly used by athletes (5,9).

Data regarding AS use in weightlifters and associated psychiatric changes have been characterized by a number of investigators. Yates and coworkers in 1990 examined DSM-III-R criteria for Clusters A, B, and C personality traits and the self-reported Personality Diagnostic Questionnaire (PDQ) in individuals that were either AS users ($n = 20$), non-AS users ($n = 20$), alcoholics ($n = 20$), and non-weightlifting community controls ($n = 20$) (10). The study showed that 45% of AS users demonstrated antisocial per-

[1] Clinical and Administrative Pharmacy Division, College of Pharmacy, University of Iowa, Iowa City, IA.
[2] Department of Psychiatry, College of Medicine, University of Iowa, Iowa City, IA.
[3] Department of Psychiatry, College of Medicine, University of Oklahoma at Tulsa, Tulsa, OK.
[4] The Pennsylvania State University College of Medicine, Milton S. Hershey Medical Center, Hershey, PA.

Received 12 July 2002; and in revised form 20 Sept. 2002 and 22 Dec. 2002; accepted 22 Dec. 2002; published 12 Mar. 2003.

sonality traits ($p < 0.001$) compared to 0% of community controls. In a later study, Yates and colleagues contrasted the Buss Durkee Hostility Inventory (BDHI) scores for eight AS users and four previous AS users to 25 non-AS using weightlifters (11). There were no significant differences among AS users, non-AS users, and previous users on overall BDHI scores, but there were significant elevations on the BDHI sub-scores of assault, indirect aggression, and verbal aggression among AS users. To address the issue of psychiatric changes associated with AS use, Pope and Katz conducted interviews using DSM-III-R criteria to identify psychiatric syndromes in weightlifters that were AS users ($n = 88$) and non-users ($n = 68$) (12). Twenty-three percent of AS users experienced major mood changes of mania, hypomania, or major depression. In contrast, the rate of major mood changes was only 6% among non-AS users ($p < 0.07$).

There seems to be disagreement in the literature regarding AS-induced aggression and mood changes. Patients with underlying psychiatric disorders or significant Cluster B traits (antisocial, borderline, narcissistic, and histrionic personality disorders) are potentially more likely to use AS and experience adverse effects on mood.

We hypothesize that use of supraphysiologic doses of testosterone in men produces a significant increase in psychometric and laboratory measures of aggression that are a function of the serum concentrations of testosterone and the subjects' personality disorder or traits. Using a retrospective design, this study was designed to characterize this relationship among users and non-users of AS in a weightlifting population. It is difficult to design a randomized, prospective study that utilizes sufficiently large AS doses to definitively answer this question because human subject research institutional review boards (IRB) would consider such a study as potentially unethical due to the study risks outweighing the benefits (beneficence).

Methods

Participants

Male weightlifters between the ages of 21 to 40 were recruited by poster advertisements at local gyms in Eastern Iowa and by word-of-mouth. All participants were regular weightlifters that either used or never used AS. Former users of AS were excluded from the sample. Each was required to have a self-reported maximum bench press of greater than 200 lb. After complete description of the study to the subjects, written informed consent was obtained.

Psychiatric Assessment

The study consisted of a single visit of approximately 3 h in duration that was composed of four phases: investigator interview (TLH and BCL), self-assessment questionnaires, PSAP, and collection of urine and blood samples.

The investigator interview included a complete history that specifically included: age, ethnicity, employment status, martial status, alcohol use, illicit and prescribed drug use, nutritional supplementation, and maximum bench press. The classification of the participants as anabolic steroid users or nonuser's classification was based on the drug use self-report of the patients in these interviews. The three psychometric rating scales were administered: the 14-item Hamilton Anxiety Scale (HAM-A) (13), the 24-item Hamilton Depression Scale (HAM-D) (14), and the 28-item Modified Manic State Rating Scale (MMRS) (15). Additionally, participants were asked to complete two self-assessment questionnaires, the PDQ-R (16) and the BDHI (17).

The PSAP was used to objectively quantify aggression. The aggression paradigm used the version of the PSAP developed by Cherek (18,19). Participants were placed in a laboratory equipped with a desk, a computer monitor, a response console, and a chair. The response console consisted of an aluminum box with two buttons labeled A and B. Participants were told that they were paired with another participant (sham opponent) similar to themselves. The sham opponent would be competing against them in this computer game via modem. The participants had the option of pushing either Button A or B. Pressing Button A 100 times would earn 1 point that would be worth a pre-determined dollar amount after the game was completed. Alternatively, pressing the B button ten times would subtract 1 point (money) from their opponent. Pressing the B button was defined as the aggressive response (point subtraction) because it did not earn points/money for the participant but only subtracted points/money from the sham opponent (19). The number of B presses, which correlates with aggression, is the primary outcome measure of this paradigm. Each participant completed three 25-min sessions of the PSAP, with a 5-min break between each session. Once completed, participants answered two questions in writing regarding their PSAP opponent: "Please describe the individual you were paired with and what were they like?" "Who subtracted more points, you or your opponent?" These questions were used to determine whether the participants remained blinded to the fictitious nature of their opponent.

Laboratory Assessment

Each participant provided a urine specimen for testing of illicit drug use (Biosite Diagnostics, California). Blood samples were obtained for the determination of total free and weakly bound testosterone. Total testosterone was determined using a solid-phase radioimmunoassay, (Diagnostic Products Corp., Los Angeles, California) based on testosterone-specific antibodies that are immobilized to the wall of polypropylene tubes along with an ^{125}I-labeled testosterone tracer. The interassay coefficients of variation for the assay averaged 13% at a mean value of 84 ng/dL and less than 5% at a mean value of 603 ng/dL. Functional sensitivity of the total testosterone assay in our laboratory (LMD) is 15 ng/dL. The male reference range for the assay was 250 to 900 ng/dL and 20 to 80 ng/dL for females. Free and bioavailable (weakly bound) testosterone was measured using a ^{3}H-testosterone exchange equilibrium assay as previously described. A saturated ammonium sulfate solution was used to precipitate sex- hormone-binding globulin-bound testosterone from the free and albumin-bound testosterone. The mass of free and weakly bound testosterone was determined by multiplying the total testosterone level by the percent free and weakly bound value. Interassay coefficients of variation for this and the free and weakly bound testosterone assay averaged 7% at a mean of 26%. The male reference range for the mass of free and weakly bound testosterone is 50 to 585 ng/dL, while the female range is 1 to 20 ng/dL.

Free testosterone in serum was measured using a Coat-A-Count Free Testosterone radioimmunoassay kit from Diagnostics Products (Los Angeles, California). Results were not calculated as a function of total testosterone and sex-hormone-binding globulin or some other parameter, but interpolated from a standard curve calibrated in free testosterone concentrations. Sensitivity of the free testosterone RIA was 0.2 pg/mL, and the intra-assay coefficient of variation averaged 5.2%.

Data Analysis

Comparisons of continuous variables between testosterone users and non-users were performed with a parametric (unpaired t-test)

or non-parametric (Mann-Whitney) test where appropriate, based on the underlying distribution (20,21). For those psychometric tests that were significantly different between groups, correlations with testosterone were examined separately for testosterone users and nonusers, using Spearman rank correlation. All tests were two-tailed, and an alpha level of 0.05 was considered as significant.

Results

Thirty-two participants were recruited and provided informed consent. Of the 32, two subjects had a urine drug screen that was positive for stimulants such that they were excluded from the final analysis, while an additional two subjects were excluded because of a prior history of anabolic steroid use. According to the interviews of the 28 remaining participants, ten admitted to current use of anabolic steroids. Table 1 presents the drug histories obtained from the ten subjects. For all subsequent analyses, the contrasts between the users and the non-users were based on the history of anabolic steroid use.

The demographic variables collected from the subjects included age, ethnicity, employment status, martial status, alcohol use, illicit drug use, prescribed drug use, nutritional supplementation, and maximum bench press. Of these variables, the users differed from the non-users in age and maximum bench press. The users were younger 24.4 (3.8) versus 27.8 (3.8) years (Mann-Whitney $z = 2.302$, $n = 28$, $p = 0.021$) and had a greater maximum bench press 377 (63) versus 293 (64) lb (Mann-Whitney: $z = 2.763$, $n = 27$, $p = 0.006$). The results of the testosterone measurements for the users and non-users are presented in Table 2. Between the users and nonusers there was greater than a four-fold difference in the means of the total testosterone concentrations, greater than a nine-fold difference in the weakly bound testosterone means, and greater than a 44-fold difference in the free testosterone means. The laboratory determination of weakly bound testosterone provided the most explanatory power ($r^2 = 0.78$) in predicting use status according to logistic regression analyses of the testosterone parameters and anabolic steroid use status. Therefore, weakly bound testosterone measurement was used in all subsequent analyses of the aggression data. Importantly, weakly bound testosterone is biologically active (22).

The B response of the PSAP measures aggression. Table 3 demonstrates the differences in the aggressive and non-aggressive responses between the AS-users and the non-users. The B responses per point subtraction indicated that the anabolic steroid users were more aggressive than the non-users of anabolic steroids (Mann-Whitney: $z = 2.253$, $n = 28$, $p = 0.024$). The scoring of the

TABLE 1—*Drug histories of anabolic steroid user group.*

Subject	AS Use, years	"Stacks" number*	Current AS†	Current Other Drugs	Total *T*, ng/dL
120	0.5	8	Metandrostenolone 75 mg/week Testosterone 400 mg/week	Clomiphene 300–400 mg/day	864
121	2.5	5	Testosterone 600 mg/week Nandrolone 400 mg/week		2168
122	2.5	10	Metandrostenolone 50–100 mg/week Testosterone 200 mg/week Nandrolone 200 mg/week		937
125	Refused to divulge drug history				1042
126	Refused to divulge drug history				2315
127	4	30	Testosterone 900 mg/week	Protein powder	3078
128	1	3	Boldenone‡ 200 mg/week Testosterone 250 mg/week	ECA stack (ephedrine, caffeine, aspirin) Yohimbine Liothyronine Creatine	519
129	1	3	Testosterone 700 mg/week	Clomiphene 50 mg/d Protein powder multivitamin	3503
130	<1	1	Testosterone 600 mg/week	Protein powder Creatine	1759
132	4	20	Boldenone 300 mg/week	Creatine Glutamine multivitamin	4786

* A stack equals the numbers of individual courses of anabolic steroid exposure in the subject. Stacks reportedly typically range from 7 to 14 weeks or longer.

† The threshold androgenic doses for the above anabolic steroids are reported to be as follows: metandrostenolone 10 mg/day orally, testosterone ester intramuscular, 200 mg/week, and nandrolone decanoate 200 mg/week (26).

‡ Boldenone is an anabolic steroid used in veterinary practice.

TABLE 2—*Testosterone panel contrasting anabolic steroid users versus non-users.*

Variable	Nonusers, mean (SD) ($n = 18$)	Users, mean (SD) ($n = 10$)	Test Statistic	*P*-Value
Total (ng/dL)	494 (187)	2097 (1366)	$z = 3.980$, $n = 28$	<0.0001
Weakly bound (ng/dL)	195 (109)	1886 (1397)	$z = 4.219$, $n = 28$	<0.0001
Free (ng/dL)	4.8 (8.4)	211 (310)	$z = 3.867$, $n = 27$	<0.0001

NOTE: z = nonparametric Mann-Whitney test.

TABLE 3—*Aggressive and non-aggressive response on the Point Subtraction Aggression Paradigm (PSAP).*

Variable	Nonusers ($n = 18$)	Users ($n = 10$)	Test Statistic	*P*-Value
B/point subtraction (aggression)	27.3 (23.1)	116.1 (127.2)	$z = 2.253$, $n = 28$	0.024
B/min (aggression)	11.9 (7.9)	43.2 (47.8)	$z = 2.493$, $n = 28$	0.013
A/min (nonaggression)	246 (43)	231 (74)	$t = 0.683$, $df = 26$	0.50

NOTE: z = nonparametric Mann-Whitney test.

TABLE 4—*Cluster B personality disorder scores for anabolic steroid users and non-users (PDQ-R).*

Variable	Nonusers ($n = 18$)	Users ($n = 10$)	Test Statistic	*P*-Value
PDQ-Cluster B	9.3 (5.6)	16.1 (8.3)	$z = 2.308$, $n = 28$	0.0210
PDQ-histrionic	1.3 (1.5)	2.8 (1.8)	$z = 2.110$, $n = 28$	0.0349
PDQ-narcissistic	1.9 (1.3)	2.7 (2.3)	$z = 0.783$, $n = 28$	0.4337
PDQ-antisocial (adult)	1.6 (0.5)	3.6 (1.4)	$z = 3.841$, $n = 28$	0.0001
PDQ-antisocial (child)	1.2 (1.7)	1.1 (1.3)	$z = 0.258$, $n = 28$	0.7967
PDQ-borderline	3.2 (3.0)	5.9 (3.3)	$z = 2.393$, $n = 30$	0.0167

NOTE: z = nonparametric Mann-Whitney test.

BDHI is composed of a total score and two sub-scores, the hostility factor, and the aggression factor. Of the three items, only the aggression factor differentiated the AS-users from the non-users, 18.2 (7.3) versus 13.1 (5.2), respectively ($t = 2.169$, $df = 26$, $p = 0.04$).

The total scores on the PDQ-R did not differ between the AS-users and non-users. However, the two groups did differ in that the AS-users Cluster B scores were greater than the non-users, 16.1 (8.3) versus 9.3 (5.6) (Mann-Whitney: $z = 2.308$, $n = 28$, $p = 0.021$). Of the four Cluster B personality disorders, the AS-users scores for antisocial, borderline, and histrionic personality disorder were greater for the users than the non-users. For the ten users, the prevalence rates for the DSM-IV diagnosis of histrionic, narcissistic, borderline, and antisocial personality disorder were 10, 20, 50, and 30%, respectively. For the 18 non-users, the prevalence rates for the DSM-IV diagnosis of histrionic, narcissistic, borderline, and antisocial personality disorder were 11, 0, 50, and 0%, respectively. Chi-square analyses detected a significant difference in the prevalence rates for only antisocial personality disorder between the users and the non-users (Fisher's Exact Test, $p = 0.0366$). Table 4 presents the differences in these scores.

The affective symptom assessments, the HAMD (depression) and MMRS (mania), differed between the two groups. The mean total HAMD scores for the users 6.0 (4.2) (range = 1 to 15) were greater than the non-users 2.0 (2.1) (range = 0 to 7) (Mann-Whitney: $z = 2.832$, $n = 28$, $p = 0.005$). The mean total MMRS scores for the users 8.6 (9.3) (range = 0 to 31) were greater than the non-users 2.2 (3.3) (range = 0 to 14) (Mann-Whitney: $z = 3.394$, $n = 27$, $p = 0.015$). Individual item analysis of the HAMD and MMRS was performed. Six of the mean scores of individual items on the HAMD (24 items) and five of the mean scores of individual items on the MMRS (28 items) were higher in the AS-users versus the non-users at the $p < 0.05$ level. According to the HAMD interview, the items of depressed mood, agitation, psychic anxiety, somatic anxiety, hypochondriasis, and hopelessness were rated higher among the testosterone users. According to the MMRS interview, the items of hypertalkativeness, restlessness, making threats, irritability, and being sexually preoccupied were rated higher among the testosterone users.

The following variables were identified as demonstrating differences between anabolic steroid users and non-users: total testosterone, weakly-bound testosterone, free testosterone, BDHI aggression factor, PDQ-Cluster B scores, MMRS scores, HAMD scores, and PSAP (B presses per point-subtraction). Simple linear regression correlations were determined between the weakly bound testosterone concentrations and the other variables for the non-users only. None of these non-user-dependent variables correlated with the weakly bound testosterone concentrations.

Discussion

The subjective (BDHI) and objective (PSAP) assessments of aggression concluded that supra-normal serum testosterone concentrations were associated with increased aggression. However, the PDQ-R results suggest that this finding was confounded by the personality disorder profile of the steroid users. Anabolic steroid users

demonstrated Cluster B personality disorder traits. As demonstrated in Table 4, the AS-user scores for the Cluster B personality disorders were higher for antisocial, borderline, and histrionic personality disorders. Only the narcissistic personality scores were similar between the two groups. Additionally, the diagnosis of antisocial personality disorder was more prevalent in the users 30% (3/10) than the non-users (0/18). The non-users' antisocial personality disorder rate is similar to that observed in community controls. The observed prevalence rate for antisocial personality disorder in the Iowa City community was estimated to be 0.4% (1/235) (23). These findings led to the conclusion that anabolic steroid users were significantly more aggressive than non-using weightlifters. Unfortunately, we were unable to determine whether this increased aggression was caused by elevated serum testosterone levels or merely reflective of intrinsic personality differences among individuals who chose to use anabolic steroids.

One difficulty interpreting personality scores in an AS-using group is to differentiate possible personality risk factors from changes in personality measures due to steroid use. Separating cause and effect is difficult; however, one strategy can be used to examine this issue. Antisocial personality questions in the PDQ-R include questions for behavior and personality before age 15 (conduct disorder) and a separate section for questions on personality after age 18. A significant elevation in PDQ-R responses prior to age 15 suggests this personality type might increase the risk of eventual drug use. Equivalent scores between our two groups in this early age group would suggest that the personality measures difference might be drug-induced, occurring only after significant exposure to steroids. To examine this possible relationship, we compared the average number of symptoms found in each group before 15 and the number of symptoms found in each group after age 18. The average number of symptoms found in each group before age 15 years did not differ between the AS-users (mean = 1.1 symptoms) and non-users (mean = 1.2 symptoms) (unpaired $t = 0.197$, $df = 28$, $p = 0.85$). However, the number of symptoms between each group after age 18 did differ between the AS-users (mean = 3.6 symptoms) and non-users (mean = 1.6 symptoms) (unpaired $t = 5.530$, $df = 28$, $p < 0.0001$). Thus, these data suggest a drug-induced component to the antisocial traits of the AS-users.

The low scores for narcissistic personality traits that were equivalent between the two groups are noteworthy. A significant number of casual steroid users have a primary cosmetic reason for using steroids. Some have postulated this group of casual users may have narcissistic features that contribute to risk of steroid use. The group of subjects in our study did not demonstrate elevated narcissism. Risk factors for the use of anabolic steroids may differ between users that have a primary cosmetic motivation and those that have a primary competitive and bodybuilding motivation. Most of our weightlifters participated in bodybuilding competitions. We cannot rule out the possible role of narcissism in other samples of steroid users motivated primarily by cosmetic reasons.

The 50% prevalence rate of borderline personality disorder requires further explanation. Self-report personality disorder measures like the PDQ-IIIR have limitations. High scores may indicate an increased risk for the presence of a personality disorder. However, the agreement of PDQ-IIIR assessments with direct interviews in some populations is not high. Our estimates of personality disorder rates using the PDQ-IIIR may be upper limit estimates (24,25). Our results support further study of the interaction of personality disorder and anabolic steroid use on behavior. Future studies should include a direct interview assessment of DSM-IV personality disorder.

The two instruments that measured affective disorder symptomatology, the HAMD and MMRS, suggested more affective disorder symptoms overall in the anabolic steroid users. The individual item-analyses of the instruments suggested that the affective symptoms that separated the users from the non-users were depressed mood, agitation, psychic anxiety, somatic anxiety, hypochondriasis, and hopelessness from the HAMD, and hyper-talkativeness, restlessness, making threats, irritability, and being sexually preoccupied from the MMRS. Since none of the study subjects met the criteria for a DSM-IV diagnosis of either major depression or acute mania, it was concluded that the increased affective symptoms were likely an indirect measurement of the increased aggression and personality disorder pathology of the anabolic steroid users. These findings are in agreement with a previous study in which the authors (PJP) were unable to discern an increase in affective disorder pathology in middle-aged volunteers being administered testosterone cypionate doses of up to 500 mg/week for 14 weeks. None of these patients had any personality traits or disorders or any past history of affective illness (8). Another explanation for the findings in this study is that anabolic steroids produce independent affective symptoms that do not reach the threshold for DSM-IV diagnostic criteria. Such sub-syndromal symptoms may contribute to a level of subjective distress but not reach the level seen in clinical affective disorders.

Our findings, while not conclusive, are consistent with prior research studies (3–5,7–9) that suggest that AS use promotes aggression among "normal healthy males" (negative psychiatric history) and typical users of AS in the general population such as weightlifters. All of the studies suggest either directly or indirectly that there is a dose-dependent effect of anabolic steroids on aggression as measured by the BDHI and PSAP. The PSAP has been utilized to measure aggression associated with alcohol, caffeine, secobarbital, nicotine, benzodiazepines, amphetamines, and marijuana as well as male parolees (5) since 1981, while the BDHI has been utilized as a psychometric tool for measuring aggression since 1957 (17). Thus, after considering the breadth of the anabolic steroid scientific literature, it would seem that the finding that AS promote aggression meets the Daubert Criteria (27).

References

1. Conacher GN, Workman DG. Violent crime possibly associated with anabolic steroid use. Am J Psychiatry 1989;146:679.
2. Pope HG, Jr., Katz DL. Affective and psychotic symptoms associated with anabolic steroid use. Am J Psychiatry 1988;145:487–90.
3. Matsumoto AM. Effects of chronic testosterone administration in normal men: safety and efficacy of high dosage testosterone and parallel dose-dependent suppression of luteinizing hormone, follicle stimulating hormone, and sperm production. J Clin Endocrinol Metab 1990;70: 282–7.
4. Su TP, Pagliaro M, Schmidt PJ, Pickar D, Wolkowitz O, Rubinow DR. Neuropsychiatric effects of anabolic steroids in male normal volunteers. JAMA 1993;269:2760–4.
5. Kouri EM, Lukas SE, Pope HG, Jr., Oliva PS. Increased aggressive responding in male volunteers following the administration of gradually increasing doses of testosterone cypionate. Drugs and Alcohol Dependence 1995;40:73–9.
6. Bhasin S, Storer TW, Berman N, Callegari C, Clevenger B, Phillips J, et al. The effects of supraphysiologic doses of testosterone on the muscle size and strength in normal men. N Engl J Med 1996;335:1–7.
7. Tricker R, Casaburi R, Strorer TW, Clevenger B, Berman N, Shirazi A, et al. The effects of supraphysiological doses of testosterone on angry behavior in healthy eugonadal men—a clinical research center study. J Clin Endocrinol Metab 1996;81:3754–8.
8. Yates WR, Perry PJ, MacIndoe J, Holman T, Ellingrod V. Psychosexual effects of three doses of testosterone cycling in normal men. Biol Psychiatry 1999;45:254–60.

9. Pope HG, Jr., Kouri EM, Hudson JI. Effects of supraphysiologic doses of testosterone on mood and aggression in normal men: a randomized controlled trial. Arch Gen Psychiatry 2000;57:133–40.
10. Yates WR, Perry PJ, Anderson KH. Illicit anabolic steroid use: a controlled personality study. Acta Psychiatr Scand 1990;81:548–50.
11. Yates WR, Perry PJ, Murray S. Aggression and hostility in anabolic steroid users. Biol Psychiarty 1992;31:1232–4.
12. Pope HG, Jr., Katz DL. Psychiatric and medical effects of anabolic-androgenic steroid use. Arch Gen Psychiatry 1994;51:375–82.
13. Hamilton M. The assessment of anxiety states by rating. Br J Med Psychol 1959;32;50–5.
14. Hamilton M. Development of a rating scale for primary depressive illness. Br J Soc Clin Psychol 1967;6:278–96.
15. Blackburn IM, Loudon JB, Ashworth CM. A new scale for measuring mania. Psychol Med 1977;7;453–8.
16. Hyler SE, Reider RO, Williams JBW. The personality diagnostic questionnaire, rev. New York: New York State Psychiatric Institute, Biometrics Research, 1987.
17. Buss AH, Durkee A. An inventory for assessing different kinds of hostility in psychiatric patients. J Consult Psychol 1957;21:343–9.
18. Cherek DR. Effects of smoking different doses of nicotine on human aggressive behavior. Psychopharmacology 1981;75:339–45.
19. Cherek DR, Schnapp W, Moeller FG, Dougherty DM. Laboratory measures of aggressive responding in male parolees with violent and nonviolent behavior. Aggressive Behavior 1996;22:27–36.
20. Hollander M, Wolfe DA. Nonparametric statistical methods. New York, NY: John Wiley & Sons, 1999.
21. Conover WJ. Practical nonparametric statistics. 3rd ed. New York, NY: John Wiley & Sons, 1998.
22. Manni A, Pardridge WM, Cefalu W. Bioavailability of albumin-bound testosterone. J Clin Endocrinol Metab 1985;61:705–10.
23. Reich J, Yates W, Nduaguba M. Prevalence of DSM-III personality disorders in the community. Soc Psychiatry Psychiatr Epidemiol 1989;24:12–16.
24. Wilberg T, Dammen T, Friis S. Comparing personality diagnostic questionnaire-4+ with longitudinal, expert, all data (LEAD) standard diagnoses in a sample with a high prevalence of axis I and axis II disorders. Compr Psychiatry 2000;41:295–302.
25. Sansone RA, Whitecar P, Meier BP, Murry A. The prevalence of borderline personality among primary care patients with chronic pain. Gen Hosp Psychiatry 2001;23:193–7.
26. Duchane D. Underground steroid handbook II. 2nd ed. Venice, CA: HLR Technical Books, 1989.
27. Rossetti AJ. The Daubert analysis. http://www.njinjury-law.com/Articles/Daubert_PAP.htm.

Additional information and reprint requests:
Paul J. Perry, Ph.D.
S-415 Pharmacy Bldg
University of Iowa
Iowa City, IA 52246