Published in final edited form as:
Drug Alcohol Depend. 2007 October 8; 90(2-3): 243–251.

Trends in non-medical use of anabolic steroids by U.S. college students: Results from four national surveys

Sean Esteban McCabe[a,*], **Kirk J. Brower**[b], **Brady T. West**[c], **Toben F. Nelson**[d], and **Henry Wechsler**[d]

a *The University of Michigan, Substance Abuse Research Center, 2025 Traverwood Dr., Suite C, Ann Arbor, MI 48105-2194, USA*

b *The University of Michigan, Addiction Research Center, Rachel Upjohn Building, 4250 Plymouth Road, Box 5740, Ann Arbor, MI 48109, USA*

c *The University of Michigan, Center for Statistical Consultation and Research, 3550 Rackham Building, Ann Arbor, MI 48109-1070, USA*

d *Harvard School of Public Health, Department of Society, Human Development and Health, 677 Huntington Avenue, Boston, MA 02115, USA*

Abstract

This study assessed the prevalence, trends, and student- and college-level characteristics associated with the non-medical use of anabolic steroids (NMAS) among U.S. college students. Data were collected through self-administered mail surveys, from 15,282, 14,428, 13,953, and 10,904 randomly selected college students at the same 119 nationally representative colleges in 1993, 1997, 1999 and 2001, respectively. The prevalence of lifetime, past-year and past-month NMAS was 1% or less and generally did not change significantly between 1993 and 2001, with one exception: past-year NMAS increased significantly among men from 1993 (0.36%) to 2001 (0.90%). Multiple logistic regression analyses revealed that lifetime and past-year NMAS were associated with student-level characteristics such as being male and participation in intercollegiate athletics. Lifetime and past-year NMAS were also positively associated with several risky behaviors, including cigarette smoking, illicit drug use, drinking and driving, and DSM-IV alcohol use disorders. Nearly 7 out of every 10 lifetime non-medical users of anabolic steroids met past-year criteria for a DSM-IV alcohol use disorder. Although the overall prevalence of NMAS remained low between 1993 and 2001, findings suggest that continued monitoring is necessary because male student-athletes are at heightened risk for NMAS and this behavior is associated with a wide range of risky health behaviors. The characteristics associated with NMAS have important implications for future practice and research.

Keywords

Anabolic steroids; College students; Substance abuse

1. Introduction

Anabolic–androgenic steroids, including synthetic testosterone, are controlled substances that have selected therapeutic uses such as treating male hypogonadism (Bhasin et al., 2006), hereditary angioedema (Church, 2004), and certain forms of anemia (Pavlatos et al., 2001).

* Corresponding author. Tel.: +1 734 998 6510; fax: +1 734 998 6508. E-mail address: plius@umich.edu (S.E. McCabe).

Anabolic–androgenic steroids also have been used in clinical research trials for muscle wasting and weight loss due to chronic diseases (Johns et al., 2005), menopausal hormonal replacement (Arlt, 2006), osteoporosis (Tracz et al., 2006), male contraception (Matthiesson and McLachlan, 2006), and depression (Pope et al., 2003). The non-medical use of anabolic steroids (NMAS) is most prevalent among adolescents and young adults in the U.S. (Johnston et al., 2005) and adverse psychiatric effects have been found to be associated with NMAS (Malone et al., 1995; Pope et al., 2000; Su et al., 1993; Yates et al., 1999). NMAS among adolescents and young adults is also documented in several other countries (Melia et al., 1996; Nilsson et al., 2001; Wichstrom and Pedersen, 2001). Although NMAS has been associated with adverse health effects on the liver, reproductive, musculoskeletal, cardiovascular, and psychological systems (Bahrke and Yesalis, 2004; Hartgens and Kuipers, 2004; Pope and Brower, 2005; Thiblin and Petersson, 2005), U.S. college students engage in NMAS to enhance physical appearance and athletic performance (Berning et al., 2004; NCAA, 2001; Pope et al., 1988). The National Collegiate Athletic Association (NCAA) prohibits the use of anabolic steroids by athletes and lists this class of drugs as banned substances (NCAA, 2006a).

Studies over the past three decades have reported a wide variation in the lifetime prevalence of NMAS among U.S. college students based on samples drawn from individual schools, multiple schools and national samples of schools (Kerber and Willisch, 1997; Meilman et al., 1995; NCAA, 2001; Presley et al., 1996; Tricker and Connolly, 1997). Yesalis (1992) reviewed college-based studies conducted before 1992 and found higher prevalence rates of NMAS than investigations conducted in the mid-to-late 1990s and 2000s. The lower prevalence rates in recent studies could be the result of actual decreases in NMAS or methodological limitations, including non-random sampling, small homogeneous samples and low response rates. Although recent national studies have improved methodology, there remains a limited understanding regarding the trends and correlates associated with NMAS among U.S. college students.

According to previous college-based investigations, individual characteristics associated with NMAS include male gender and intercollegiate athletic participation (Berning et al., 2004; Dezelsky et al., 1985; Kerber and Willisch, 1997; Presley et al., 1996; Toohey and Corder, 1981). NMAS is also associated with substance use, poor academic performance and other problem behaviors among adolescents and college students (DuRant et al., 1993; Meilman et al., 1995; Miller et al., 2005; Perko et al., 1995). Despite the evidence for higher rates of substance use, there remains limited information regarding the association between NMAS, substance use disorders based on DSM-IV criteria, and other adverse health outcomes to test whether NMAS is part of a larger cluster of problem behaviors (Biglan et al., 2004; Jessor et al., 1991).

Most evidence indicates that intercollegiate student-athletes are more likely than non-athletes to use anabolic steroids for non-medical purposes (Dezelsky et al., 1985; Pope et al., 1988), while other investigations at single colleges have not reached this conclusion (Berning et al., 2004; Selby et al., 1990). To date, there have been no nationally representative studies comparing intercollegiate student-athletes and other college students.

Few studies have examined the association between college-level characteristics and NMAS. At least three national studies in the U.S. found that NMAS did not differ between intercollegiate varsity student-athletes attending schools from three different college divisions based on athletic levels (i.e., Division I, II and III) (Anderson et al., 1991; Green et al., 2001; NCAA, 2001). More research is needed to examine possible college-level characteristics associated with NMAS. The main objective of this study was to assess the prevalence, trends, and student- and college-level characteristics associated with NMAS among U.S. college students.

2. Methods

2.1. Study population and data collection

The present study used data from 119 four-year U.S. colleges and universities that took part in the 1993, 1997, 1999, and 2001 College Alcohol Study (CAS). The participating schools were selected from the American Council on Education's list of all accredited 4-year U.S. colleges and universities. Student responses to the survey were voluntary and anonymous, and students were told that they did not have to answer any question that made them uncomfortable. College response rates declined across the four surveys and were 70% in 1993 (range 48–100%), 59% in 1997 (27–88%), 59% in 1999 (27–83%), and 52% in 2001 (22–86%). To check for potential biases introduced by the survey non-response, we calculated the Pearson correlation coefficient between the main outcome variable (each school's rate of NMAS) and their respective response rates. There were no statistically significant associations between response rates and the estimated 12-month or lifetime prevalence rates of NMAS at the college level in any of the four study years. We also incorporated sampling weights adjusting for non-response in all statistical analyses. Additional information regarding sampling methods, inclusion criteria, and weighting for the CAS are described in more detail elsewhere (e.g., Mohler-Kuo et al., 2003; Wechsler et al., 1994, 1998, 2000, 2002).

2.2. Measures

Nonmedical use of anabolic steroids (NMAS) was measured with the following item: "How often, if ever, have you used any of the drugs listed below? Do not include anything you used under a doctor's orders." Drug items included "Anabolic steroids" in each survey year between 1993 and 2001. The response scale was (1) never used to (4) used in the past 30 days. In 2001, a list of examples was also included as follows: "Anabolic steroids (either injections, like Depo-testosterone, or Durabolin- or pills, like Anadrol, Dianadrol, or Winstrol)."

Intercollegiate athletic status was measured with a single item asking "In the past 30 days, how many hours per day on average have you spent on each of the following activities?" Items included "Intercollegiate athletics" in 1993 and "Playing or practicing intercollegiate sports" in each survey year between 1997 and 2001. Responses to this item were coded into a binary indicator of any participation in intercollegiate athletics in each study year.

Binge drinking was defined as the consumption of at least five drinks in a row for men and at least four drinks in a row for women during the 2 weeks preceding completion of the questionnaire, and *frequent binge drinking* was defined as having three or more binge drinking episodes in the past 2 weeks (Wechsler et al., 1994).

Nonmedical/illicit drug use was measured with the following item: "How often, if ever, have you used any of the drugs listed below? Do not include anything you used under a doctor's orders." Drug items included marijuana, cocaine, heroin, LSD, other psychedelics, ecstasy (asked in 1999 and 2001 only), prescription opioids, sedatives, stimulants, and tranquilizers.

Drinking and driving behaviors were measured with the following item: "In the past 30 days, how many times did you do each of the following drinking and driving behaviors?" (a) Drive after drinking alcohol, (b) drive after having 5 or more drinks, and (c) ride with a driver who was high or drunk. For purposes of analysis, outcomes were dichotomized into "not at all" and "at least once."

DSM-IV alcohol abuse or dependence (American Psychiatric Association, 2000) was measured in 1999 with items adapted from the Semi-Structured Assessment for the Genetics of Alcoholism (SSAGA) to assess DSM-IV diagnosis of alcohol abuse or dependence during the

12 months preceding the survey (e.g., Bucholz et al., 1994; Hesselbrock et al., 1999; Knight et al., 2002).

Age of first intoxication was measured with the following item: "How old were you when you first got drunk?" Outcomes were dichotomized into those who "first drank to intoxication prior to age 16" and "did not drink to intoxication prior to age 16."

Mental health was assessed in 1997 and 1999 using a five-item subscale of the Short Form 36 (SF-36) that provides an indication (but not diagnosis) of depression (Ware et al., 1993). Consistent with previous research (Weitzman, 2004), a score of 100 on the SF-36 was considered the best mental health and 0 was considered the worst mental health, with scores between 0 and 38 considered to have clinical significance.

College-level variables available for the CAS included geographical region (Northeast, South, North Central, and West), admissions selectivity (most competitive, competitive, and less competitive, based on Barron's Profiles of American Colleges), private/public status, commuter status, size of student enrollment (>10,000 students, 5001–10,000, 1000–5000, <1000), urbanization (suburban/urban and rural/small town), and college division athletic level (Division I, II or III).

2.3. Data analysis

Sampling weights were applied to the student-level data to make sure that estimates at a given school reflected the baseline demographic composition of full-time students at the school (in terms of gender, race and age). Statistical analyses accounting for the clustered designs were performed using the SAS statistical software package (Release 9.1.3) (SAS Institute, 2005). A Taylor Series Linearization approach (e.g., Rust, 1985) was used to estimate robust standard errors that reflected the clustered design (where colleges were the primary sampling units). Hierarchical generalized linear models (HGLMs) that provide robust standard error estimates based on multilevel and clustered sampling designs and incorporate sampling weights were fitted using the HLM software package (Raudenbush et al., 2006; Raudenbush and Bryk, 2002).

To examine the changing prevalence rates of NMAS over time, both overall and for the male and female subpopulations, we first estimated weighted prevalence rates for each sample year, in addition to design-based standard errors for the estimated rates. The estimated lifetime, past-year, and past-month prevalence rates of NMAS were compared between 1993, 1997, 1999 and 2001 using multiple pair-wise comparisons (Altman and Bland, 2003). A Bonferroni correction was applied to reduce the likelihood of making a Type I error when performing the multiple comparisons (e.g., Holland and Coppenhaver, 1988). In addition to pairwise comparisons, linear trends in the prevalence of each type of NMAS were evaluated (both overall and separately by gender) using logistic regression adjusting for the clustering of students by year within the sampled schools.

HGLMs for Bernoulli-distributed data were then fitted in each study year to predict the odds of lifetime and past year NMAS at the student level. Based on the investigative nature of this study and previous research that has examined correlates associated with NMAS among college students, we considered the following student-level characteristics as predictors: sex, race, marital status, age, living arrangement, fraternity/sorority membership, grade point average, and intercollegiate athletic participation. The models also considered the following college-level characteristics: urbanization, geographical region, commuter status, school enrollment size, NCAA athletic division, admissions selectivity criteria, and public/private status. Ninety-five percent confidence intervals (CI) were calculated in HLM for the adjusted odds ratios (AORs) associated with one-unit changes in the predictors. Similar HGLM approaches were

used in each year to examine NMAS as a *predictor* of engaging in various risky substance use behaviors (e.g., frequent binge drinking), and of having other adverse mental health outcomes (e.g., DSM-IV alcohol use disorders) while controlling for relevant individual- and college-level characteristics.

2.4. Sample

The College Alcohol Study (CAS) sampled respondents from 119 colleges in the 1993 (n = 15,282), 1997 (n = 14,428), 1999 (n = 13,953) and 2001 (n = 10,904) CAS surveys. The mean age of each sample was approximately 21 years old. In each survey year, at least 76% of students were white (with a maximum of 82% in 1993), and the remainder of the students were somewhat evenly distributed between responses of black, Asian, and "other." Approximately 23% of students attended schools located in the Northeast, 29% in the South, 30% in the North Central region and 18% in the West. The percentage of students attending commuter schools ranged from 12 to 14% across the four survey years. Although there was some slight variation between the study years, the CAS samples tended to be nationally representative cross-sections of students enrolled at 4-year colleges in the U.S. (U.S. Department of Education, 2002, 2004).

3. Results

3.1. Prevalence estimates and trends of NMAS

The estimated lifetime prevalence rate of NMAS was approximately 1.0% and held steady in the four survey years between 1993 and 2001 (Table 1). Based on multiple pair-wise comparisons, there were no significant differences in the rates, with the exception of the increase in past-year NMAS between 1993 and 2001. A significant linear trend for 12-month NMAS was found, with a 1-year increase resulting in an expected 10% increase in the odds of past-year NMAS (OR = 1.10; 95% CI = 1.03, 1.17) during this time period. This trend appears to be driven by an increase among males (OR = 1.11, 95% CI = 1.04, 1.20).

3.2. Student- and college-level characteristics associated with NMAS

Lifetime NMAS was more prevalent among U.S. college students who were male, married, older than 23 years of age, and/or participants in intercollegiate athletics in at least two survey years when adjusting for the other predictors in the models (Table 2). College men had significantly higher odds than college women of reporting lifetime NMAS in each survey year (AORs ranged from 5.34 to 8.52). College students who played or participated in intercollegiate athletics had increased odds as compared to non-athletes of reporting lifetime NMAS in all four survey years (AORs ranged from 1.63 to 2.43). Married students had higher odds of reporting lifetime NMAS as compared to students who were never married in 1999 and 2001. Finally, students older than 23 years of age had greater odds of lifetime NMAS as compared to students under 21 years of age in 1993 and 1997.

Many of the same associations were present for past-year NMAS. For example, college men had greater odds than college women of reporting past-year NMAS in each survey year (AORs ranged from 4.17 to 12.23, $p < 0.01$). College students who played or participated in intercollegiate athletics had increased odds as compared to non-athletes to report past-year NMAS in 1993 (AOR = 2.25, 95% CI = 1.13, 4.50, $p < 0.05$) and 1997 (AOR = 2.23, 95% CI = 1.13, 4.40, $p < 0.05$). Married students had greater odds of past-year NMAS as compared to non-married individuals in 1993 (AOR = 3.22, 95% CI = 1.02, 10.24, $p < 0.05$) and 2001 (AOR = 4.18, 95% CI = 1.07, 16.39, $p < 0.05$). Age was not associated with past-year NMAS.

Lifetime NMAS was significantly more prevalent at commuter colleges (1999 and 2001), but urbanicity, geographical region, size of student enrollment, NCAA athletic division, admission

criteria and type of college (public versus private) were not associated with either lifetime or past-year NMAS in at least two years. The variance of the random college effects in 1999 and 2001 was found to be significantly greater than zero ($p < 0.05$), suggesting that additional college-level factors which were not measured in the CAS may explain additional between-college variation in the rates of NMAS. Finally, we found no consistent associations of college-level factors in the models predicting past-year NMAS.

3.3. Relationship between NMAS and other substance use behaviors

Lifetime NMAS was significantly associated with cigarette smoking, binge drinking, marijuana use, other illicit drug use, DSM-IV alcohol use disorders and other risky health behaviors (Table 3). For example, anabolic steroid users were nearly 12 times more likely than non-users to report using cocaine in the past-month, when controlling for other related factors (AOR = 11.59, 95% CI = 5.34, 25.15). Furthermore, an estimated 21% of lifetime non-medical users of anabolic steroids met the criteria for past-year DSM-IV alcohol dependence as compared to about 6% of non-steroid users (AOR = 3.08, 95% CI = 1.66, 5.70). Further, lifetime non-medical users of anabolic steroids were over six times more likely than non-users to have driven after binge drinking in the past 30 days (AOR = 6.20, 95% CI = 3.32, 11.58). An estimated 77% of non-medical users of anabolic steroids reported using at least one illicit drug (including use of prescription drugs non-medically) in the past-year, as compared to 32% of non-steroid users (AOR = 7.93, 95% CI = 4.54, 13.86).

These same associations held true for past-year NMAS. For example, an estimated 33% of past-year anabolic steroid users met criteria for past-year DSM-IV alcohol dependence as compared to 6% of non-users (AOR = 7.42, 95% CI = 3.34, 16.48). Notably, poor mental health/depressive symptoms based on the SF-36 was not significantly associated with lifetime or past-year NMAS. Finally, the results presented in Table 3 are primarily from the 2001 survey only, but similar associations were observed in previous survey years (1993, 1997, and 1999).

4. Discussion

In the present study we found a lifetime prevalence rate of NMAS of approximately 1%, and that NMAS remained stable among U.S. college students during the period from 1993 to 2001, although we observed a significant increase in past-year NMAS among men. These findings are consistent with other national studies of U.S. college students (Meilman et al., 1995; Presley et al., 1996) and young adults over the past decade (Johnston et al., 2005). The present study found that approximately 20 in every 1000 college men and about 2 in every 1000 college women reported NMAS in their lifetime. While the increase in past-year NMAS for men between 1993 and 2001 is of concern, the actual rate of NMAS is still low.

Among U.S. college students, the prevalence of NMAS is considerably lower than the non-medical use of other prescription drugs such as benzodiazepines, opioids and stimulants (McCabe, 2005; McCabe et al., 2005a,b; SAMHSA, 2005). In addition, the lifetime prevalence of NMAS in the present study is lower than lifetime rates of NMAS among high school students in other studies (e.g., Buckley et al., 1988; DuRant et al., 1993; Johnston et al., 2005). While the lower prevalence rates in the present study could be the result of actual differences in NMAS between high school and college students, some of the differences could be attributed to methodological factors such as survey mode effects, non-random sampling, differences in question wording, and response rates (Fendrich and Johnson, 2001). There are also important developmental differences and selection effects between high school and college student populations. For example, high school students who do not intend to complete college report considerably higher rates of NMAS than individuals who intend to complete college (Johnston et al., 2005).

Our findings were consistent with previous investigations which found increased risk for NMAS among men (Johnston et al., 2005; Meilman et al., 1995; Presley et al., 1996). The present study provides new evidence that lifetime and past-year NMAS is higher among married college students. This finding deserves more attention in future research because marriage is typically protective against most forms of substance abuse (Bachman et al., 1997; SAMHSA, 2006). The present study also found that past-year NMAS was not associated with age, suggesting that the association between age and lifetime NMAS was likely due to an "age effect" or a longer window for potential exposure to NMAS. The multivariate findings also add a new dimension because college-level characteristics were examined and were not found to be significantly associated with NMAS, with the exception of commuter status. While commuter status was significantly associated with lifetime NMAS, there was no such association between commuter status and past-year NMAS. Finally, our findings also concur with previous national research indicating that NMAS was similar as a function of Division I, II, or III athletic levels (NCAA, 2001).

The findings of the present study were consistent with past studies demonstrating that intercollegiate student-athletes were more likely to report NMAS than non-athletes (Dezelsky et al., 1985; Pope et al., 1988). Indeed, the respective prevalence rates of lifetime and past-year NMAS were about 3.3% and 1.5% among male student-athletes in 2001. If the results from the present study were extrapolated to the total population of 214,186 NCAA male student-athletes in 2001 (NCAA, 2006c), more than 7000 male student-athletes used anabolic steroids for non-medical purposes in their lifetime and 3200 male student-athletes did so in the past 12 months. The higher prevalence rate among student-athletes could be motivated by a desire to improve athletic performance and treat sports injuries (NCAA, 2001). A previous college-based study found that 12% of current non-steroid using intercollegiate student-athletes who participated in strength sports would use anabolic steroids to improve their athletic performance if they would guarantee success and if the athletes could be assured of not testing positive for use (Tricker and Connolly, 1997).

We found that non-medical steroid users were more likely to engage in other substance use, abuse, and risky health behaviors. These findings complement evidence that adolescent and collegiate anabolic steroid users are more likely to use alcohol and other drugs in the U.S. (DuRant et al., 1993; Meilman et al., 1995; Yesalis et al., 1993) and other countries (e.g., Nilsson et al., 2001; Wichstrom and Pedersen, 2001).

4.1. Strengths and limitations

This investigation has several strengths and extends previous research on NMAS among U.S. college students. First, the study featured data from four large nationally representative samples of students attending 119 four-year colleges and universities. The large sample sizes allowed for in-depth and multivariate analyses of several individual-level and college-level characteristics. Second, the study included clinically relevant substance abuse and other health measures (e.g., DSM-IV alcohol use disorders). Third, the study examined prevalence rates by lifetime, past-year, and past-month timeframes. Lifetime prevalence of NMAS is especially relevant because some of the gains in muscle size and strength that motivate athletes to use are initially attainable only with NMAS, but sustainable in part with rigorous training alone (Yesalis et al., 2000).

The present study also had some limitations. First, the survey did not assess the frequency, duration, or quantity of anabolic steroid use, which is limiting because adverse effects are most likely to occur with prolonged, high-dose use (Thiblin and Petersson, 2005). Second, the low prevalence rates limited some statistical analyses, such as comparing NMAS across individual college campuses. Third, the study relied solely on self-reported substance use. Although self-report for substance use is generally valid when special conditions such as anonymity are

operative, validity of self-report specifically for NMAS is poorly studied (Yesalis et al., 2000). Furthermore, non-response may have introduced bias. We tried to minimize this impact by incorporating sampling weights in the statistical analyses to ensure that the demographic distribution of the sample was roughly equivalent to the total student population. Finally, because the sample consisted of full-time students attending 4-year U.S. colleges and universities only, the sample is not representative of all U.S. and international student populations.

4.2. Future practice and research

The findings of the present study have implications for clinical work and prevention efforts. Because the rates of NMAS are low, NMAS may have relatively low visibility on some college campuses compared to other abused substances. Thus, detection of NMAS may be more difficult, expertise among health professionals may be comparatively lacking, and the priority of NMAS as a college health concern may be minimized. Given that steroid use disproportionately impacts student-athletes, intercollegiate student athletic programs may be best poised to impact the problem (NCAA, 2006a, 2006b).

Of additional clinical concern is that lifetime and past-year steroid users were more likely than non-users to engage in risky drinking and other drug-taking behaviors. Therefore, health professionals should conduct thorough substance abuse histories when working with non-medical users of anabolic steroids. Moreover, health professionals working with anabolic steroid users should assess for DSM-IV alcohol use disorders because almost 7 out of every 10 lifetime users met past-year criteria for a DSM-IV alcohol use disorder. The high rates of concurrent polydrug use found among anabolic steroid users are especially worthy of attention because various combinations of these drugs can interact to adversely affect behavior and alter functioning of chemical systems in the brain (Brower, 2002; Petersson et al., 2006; Steensland et al., 2005).

Despite high rates of polysubstance use and alcohol use disorders, clinically significant poor mental health and depressive symptoms did not differ significantly between lifetime and past-year non-medical users of anabolic steroids and non-users. This finding was somewhat unexpected given the extensive medical literature on the adverse psychiatric effects associated with NMAS. One possible reason is that the low rates of poor mental health in this study, in comparison to other national studies of college students (Kisch et al., 2005), could suggest that the measure employed in this study was insensitive to detecting a full range of depressive symptoms. Another possible explanation is that steroid-associated depressive symptoms generally occur during the first 3 months after stopping NMAS (Brower, 2002), and this was not a timeframe asked of respondents. Indeed, the SF-36 questions are keyed to the past 30 days, so the likelihood that this timeframe included the 3 months immediately following cessation of NMAS was low. At least one case-control study found higher rates of illicit substance use, abuse, or dependence among 48 male anabolic steroid users as compared to 45 non-users but no significant associations in Axis I disorders (Kanayama et al., 2003), which complements the findings of the present study.

The present study reinforces other national work showing that NMAS is less prevalent than other forms of non-medical use of prescription drugs among U.S. college students. Future research is needed to examine sources of obtaining anabolic steroids. The majority of collegiate non-medical users of anabolic steroids and other prescription drugs appear to obtain these drugs from non-physician sources, which can result in adverse health consequences (Forman, 2006; McCabe and Boyd, 2005; NCAA, 2001). Further, non-medical users may unknowingly obtain counterfeit, adulterated, and/or contaminated drugs that could pose dangers to their health. Future work should also examine similarities and differences between college and non-college young adults since there is some evidence that NMAS is higher among non-college

bound secondary school students as compared to college-bound students (Johnston et al., 2005). Finally, while the present study identified some important individual-level characteristics associated with NMAS, more work is needed to identify motivational, environmental, college-level and biological factors which may contribute to the initiation of NMAS. Such information will lead to a more comprehensive understanding of NMAS during the transition from adolescence to young adulthood that takes into account the developmentally distinctive aspects of emerging adulthood (Arnett, 2005).

Acknowledgements

The College Alcohol Study data were collected under research grants from the Robert Wood Johnson Foundation (PI: Henry Wechsler). The development of this manuscript was supported by a research grant DA019492 (PI: Sean Esteban McCabe) from the National Institute on Drug Abuse.

References

Altman DG, Bland JM. Interaction revisited: the difference between two estimates. BMJ 2003;326:219. [PubMed: 12543843]

American Psychiatric Association. DSM-IV-TR: Diagnostic and Statistical Manual of Mental Disorders. 4. American Psychiatric Association; Washington, DC (Text Revision): 2000.

Anderson WA, Albrecht RR, McKeag DB, Hough DO, McGrew CA. A national survey of alcohol and drug use by college athletes. Phys Sportsmed 1991;19:91–104.

Arlt W. Androgen therapy in women. Eur J Endocrinol 2006;154:1–11. [PubMed: 16381985]

Arnett JJ. The developmental context of substance use in emerging adulthood. J Drug Issues 2005;35:235–254.

Bachman, JG.; Wadsworth, KN.; O'Malley, PM.; Johnston, LD.; Schulenberg, JE. Smoking, Drinking, and Drug Use in Young Adulthood: The Impacts of New Freedoms and New Responsibilities. Lawrence Erlbaum Associates; Mahwah, NJ: 1997.

Bahrke MS, Yesalis CE. Abuse of anabolic androgenic steroids and related substances in sport and exercise. Curr Opin Pharmacol 2004;4:614–620. [PubMed: 15525553]

Berning JM, Adams KJF, Stamford BAF, Finewman IM. Prevalence and perceived prevalence of anabolic steroid use among college-aged students. Med Sci Sports Exerc 2004;36:S350.

Bhasin S, Cunningham GR, Hayes FJ, Matsumoto AM, Snyder PJ, Swerdloff RS, Montori VM. Testosterone therapy in adult men with androgen deficiency syndromes: an endocrine society clinical practice guideline. J Clin Endocrinol Metab 2006;91:1995–2010. [PubMed: 16720669]

Biglan, A.; Brennan, PA.; Foster, SL.; Holder, HD. Helping Adolescents at Risk: Prevention of Multiple Problem Behaviors. Guilford Press; New York, NY: 2004.

Brower KJ. Anabolic steroid abuse and dependence. Curr Psychiatry Rep 2002;4:377–387. [PubMed: 12230967]

Bucholz KK, Cadoret R, Cloninger CR, Dinwiddie SH, Hesselbrock VM, Nurnberger JI Jr, Reich T, Schmidt I, Schuckit MA. A new, semi-structured psychiatric interview for use in genetic linkage studies: a report on the reliability of the SSAGA. J Stud Alcohol 1994;55:149–158. [PubMed: 8189735]

Buckley WE, Yesalis CE, Friedl KE, Anderson WA, Streit AL, Wright JE. Estimated prevalence of anabolic steroid use among male high school seniors. JAMA 1988;260:3441–3445. [PubMed: 3210283]

Church JA. Oxandrolone treatment of childhood hereditary angioedema. Ann Allergy Asthma Immunol 2004;92:377–378. [PubMed: 15049404]

Dezelsky TL, Toohey JV, Shaw RS. Non-medical drug use behavior at five United States universities: a 15-year study. Bull Narc 1985;2:49–53. [PubMed: 3878173]

DuRant RH, Rickert VI, Ashworth CS, Newman C, Slavens G. Use of multiple drugs among adolescents who use anabolic steroids. N Engl J Med 1993;328:922–926. [PubMed: 8446139]

Fendrich M, Johnson TP. Examining prevalence differences in three national surveys of youth: impact of consent procedures, mode, and editing rules. J Drug Issues 2001;31:615–642.

Forman RF. Innovations: Alcohol & drug abuse: narcotics on the net: the availability of Web sites selling controlled substances. Psychiatr Serv 2006;57:24–26. [PubMed: 16403726]

Green GA, Uryasz FD, Petr TA, Bray CD. NCAA study of substance use and abuse habits of college student-athletes. Clin J Sport Med 2001;11:51–56. [PubMed: 11176146]

Hartgens F, Kuipers H. Effects of androgenic-anabolic steroids in athletes. Sports Med 2004;34:513–554. [PubMed: 15248788]

Hesselbrock M, Easton C, Bucholz KK, Schuckit M, Hesselbrock V. A validity study of the SSAGA—a comparison with the SCAN. Addiction 1999;94:1361–1370. [PubMed: 10615721]

Holland B, Coppenhaver MD. Improved bonferroni-type multiple testing procedures. Psychol Bull 1988;104:145–149.

Jessor, R.; Donovan, JE.; Costa, FM. Beyond Adolescence: Problem Behavior and Young Adult Development. Cambridge University Press; Cambridge, England: 1991.

Johns, K.; Beddall, MJ.; Corrin, RC. Cochrane Database Syst Rev. 4. 2005. Anabolic steroids for the treatment of weight loss in HIV-infected individuals; p. CD005483

Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the Future: National Survey Results on Drug Use, 1975–2004: Secondary School Students. 1. NIDA; Bethesda, MD: 2005. NIH Publication No. 05–5727

Kanayama G, Pope HG, Cohane G, Hudson JI. Risk factors for anabolic–androgenic steroid use among weightlifters: a case–control study. Drug Alcohol Depend 2003;71:77–86. [PubMed: 12821208]

Kerber, L.; Willisch, L. Texas Survey of Substance Abuse Among University Students. Texas Commission on Alcohol and Drug Abuse. 1997 [Accessed online July 22, 2005]. http://www.tcada.state.tx.us/research/college/1997/college97.pdf

Kisch J, Leino EV, Silverman MM. Aspects of suicidal behavior, depression, and treatment in college students: results from the spring 2000 National College Health Assessment survey. Suicide Life Threat Behav 2005;35:3–13. [PubMed: 15843320]

Knight JR, Wechsler H, Kuo M, Seibring M, Weitzman ER, Schuckit MA. Alcohol abuse and dependence among U.S. college students. J Stud Alcohol 2002;63:263–270. [PubMed: 12086126]

Malone DA, Dimeff RJ, Lombardo JA. Psychiatric effects and psychoactive substance use in anabolic–androgenic steroid users. Clin J Sport Med 1995;5:25–31. [PubMed: 7614077]

Matthiesson KL, McLachlan RI. Male hormonal contraception: concept proven, product in sight? Hum Reprod Update 2006;12:463–482. [PubMed: 16597629]

McCabe SE. Correlates of nonmedical use of prescription benzodiazepine anxiolytics: results from a national survey of U.S. college students. Drug Alcohol Depend 2005;79:53–62. [PubMed: 15943944]

McCabe SE, Boyd CJ. Sources of prescription drugs for illicit use. Addict Behav 2005;30:1342–1350. [PubMed: 16022931]

McCabe SE, Knight JR, Teter CJ, Wechsler H. Non-medical use of prescription stimulants among US college students: prevalence and correlates from a national survey. Addiction 2005a;100:96–106. [PubMed: 15598197]

McCabe SE, Teter CJ, Boyd CJ, Knight JR, Wechsler H. Non-medical use of prescription opioids among US college students: prevalence and correlates from a national survey. Addict Behav 2005b;30:789–805. [PubMed: 15833582]

Meilman PW, Crace RK, Presley CA, Lyerla R. Beyond performance enhancement: polypharmacy among collegiate users of steroids. J Am Coll Health 1995;44:98–104. [PubMed: 8543731]

Melia P, Pipe A, Greenberg L. The use if anabolic–androgenic steroids by Canadian students. Clin J Sport Med 1996;6:9–14. [PubMed: 8925377]

Miller KE, Hoffman JH, Barnes GM, Sabo D, Melnick MJ, Farrell MP. Adolescent anabolic steroid use, gender, physical activity, and other problem behaviors. Subst Use Misuse 2005;40:1637–1657. [PubMed: 16253932]

Mohler-Kuo M, Lee JE, Wechsler H. Trends in marijuana and other illicit drug use among college students: results from 4 Harvard School of Public Health College Alcohol Study surveys: 1993–2001. J Am Coll Health 2003;52:17–24. [PubMed: 14717576]

National Collegiate Athletic Association, 2001. NCAA Study of Substance Use Habits of College Student-athletes. The NCAA Research Staff.

National Collegiate Athletic Association (NCAA). NCAA Banned-Drug Classes 2005–2006. 2006a [Accessed online September 14, 2006]. http://www1.ncaa.org/membership/edoutreach/health-safety/drug_testing/banneddrugclasses.pdf

National Collegiate Athletic Association (NCAA). NCAA Drug Testing Program. 2006b [Accessed online September 14, 2006]. http://www.ncaa.org/

National Collegiate Athletic Association (NCAA). Fact Sheet. Participants in NCAA-Sponsored Sports (All Divisions). 2006c [Accessed online September 14, 2006]. http://www.ncaa.org/

Nilsson S, Baigi A, Marklund B, Fridlund B. The prevalence of the use of androgenic anabolic steroids by adolescents in a county of Sweden. Eur J Pub Health 2001;11:195–197. [PubMed: 11420810]

Pavlatos AM, Fultz O, Monberg MJ, Vootkur A. Review of oxymetholone: a 17alpha-alkylated anabolic–androgenic steroid. Clin Ther 2001;23:789–801. [PubMed: 11440282]

Perko MA, Cowdery J, Wang MQ, Yesalis CS. Association between academic performance of Division 1 college athletes and their perceptions of the effects of anabolic steroids. Percept Mot Skills 1995;80:284–286. [PubMed: 7624207]

Petersson A, Garle M, Holmgren P, Druid H, Krantz P, Thiblin I. Toxicological findings and manner of death in autopsied users of anabolic androgenic steroids. Drug Alcohol Depend 2006;81:241–249. [PubMed: 16137840]

Pope, HG.; Brower, KJ. Anabolic–androgenic steroid abuse. In: Sadcock, BJ.; Sadock, VA., editors. Kaplan and Sadock's Comprehensive Textbook of Psychiatry. 8. I. Lippincott Williams and Wilkins; Philadelphia: 2005. p. 1318-1328.

Pope HG Jr, Cohane GH, Kanayama G, Siegel AJ, Hudson JI. Testosterone gel supplementation for men with refractory depression: a randomized, placebo-controlled trial. Am J Psychiatry 2003;160:105–111. [PubMed: 12505808]

Pope HG, Katz DL, Champoux R. Anabolic–androgenic steroid use among 1010 college men. Phys Sportsmed 1988;16:75–81.

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;57:133–140. [PubMed: 10665615]

Presley, CA.; Meilman, PW.; Cashin, JR. Alcohol and Drugs on American College Campuses: Use, Consequences, and Perceptions of the Campus Environment. IV. Core Institute, Southern Illinois University; Carbondale, IL: 1996. 1992–94

Raudenbush, SW.; Bryk, AS. Hierarchical Linear Models: Applications and Data Analysis Methods. Sage Publications; Newbury Park, CA: 2002.

Raudenbush, SW.; Bryk, AS.; Congdon, R. HLM 6.03: Hierarchical Linear and Nonlinear Modeling [software package]. Scientific Software International; Lincolnwood, IL: 2006.

Rust K. Variance estimation for complex estimators in sample surveys. J Official Stat 1985;1:381–397.

Selby R, Weinstein HM, Bird TS. The health of university athletes: attitudes, behaviors, and stressors. J Am Coll Health 1990;39:11–18. [PubMed: 2365926]

Steensland P, Hallberg M, Kindlundh A, Fahlke C, Nyberg F. Amphetamine-induced aggression is enhanced in rats pre-treated with the anabolic androgenic steroid nandrolone decanoate. Steroids 2005;70:199–204. [PubMed: 15763599]

Su TP, Pagliaro M, Schmidt PJ, Pickar D, Wolkowitz O, Rubinow DR. Neuropsychiatric effects of anabolic steroids in male normal volunteers. JAMA 1993;269:2760–2764. [PubMed: 8492402]

Substance Abuse and Mental Health Services Administration. National Survey on Drug Use and Health. College Enrollment Status and Past Year Illicit Drug Use among Young Adults: 2002, 2003, and 2004. Office of Applied Studies. 2005 [Accessed online October 25, 2005]. http://oas.samhsa.gov/2k5/College/college.pdf

Substance Abuse and Mental Health Services Administration. National Survey on Drug Use and Health. Alcohol Dependence or Abuse: 2002, 2003, and 2004. Office of Applied Studies. 2006 [Accessed online January 2, 2007]. http://oas.samhsa.gov/2k6/AlcDepend/AlcDepend.pdf

Thiblin I, Petersson A. Pharmacoepidemiology of anabolic androgenic steroids: a review. Fundam Clin Pharmacol 2005;19:27–44. [PubMed: 15660958]

Toohey JV, Corder BW. Intercollegiate sports participation and non-medical drug use. Bull Narc 1981;33:23–27. [PubMed: 6917769]

Tracz MJ, Sideras K, Bolona ER, Haddad RM, Kennedy CC, Uraga MV, Caples SM, Erwin PJ, Montori VM. Testosterone use in men and its effects on bone health. A systematic review and meta-analysis of randomized placebo-controlled trials. J Clin Endocrinol Metab 2006;91:2011–2016. [PubMed: 16720668]

Tricker R, Connolly D. Drugs and the college athlete: an analysis of the attitudes of student athletes at risk. J Drug Educ 1997;27:105–119. [PubMed: 9270209]

U.S. Department of Education. Fall Enrollment in Postsecondary Institutions, 1997. National Center for Education Statistics. 2002 [Accessed online January 25, 2002]. http://nces.ed.gov/pubs2000/2000160.pdf

U.S. Department of Education. Enrollment in Postsecondary Institutions, Fall 2001 and Financial Statistics, Fiscal Year 2001. National Center for Education Statistics. 2004 [Accessed online February 10, 2004]. http://nces.ed.gov/pubs2004/2004155.pdf

Ware, JE.; Snow, KK.; Kosinski, M.; Gandek, B. SF-36 Health Survey Manual and Interpretation Guide. Health Institute, New England Medical Center; Boston: 1993.

Wechsler H, Davenport A, Dowdall G, Moeykens B, Castillo S. Health and behavioral consequences of binge drinking in college. A national survey of students at 140 campuses. JAMA 1994;272:1672–1677. [PubMed: 7966895]

Wechsler H, Dowdall GW, Maenner G, Gledhill-Hoyt J, Lee H. Changes in binge drinking and related problems among American college students between 1993 and 1997. Results of the Harvard School of Public Health College Alcohol Study. J Am Coll Health 1998;47:57–68. [PubMed: 9782661]

Wechsler H, Lee JE, Kuo M, Lee H. College binge drinking in the 1990s: a continuing problem. Results of the Harvard School of Public Health 1999 College Alcohol Study. J Am Coll Health 2000;48:199–210. [PubMed: 10778020]

Wechsler H, Lee JE, Kuo M, Seibring M, Nelson TF, Lee H. Trends in college binge drinking during a period of increased prevention efforts. Findings from 4 Harvard School of Public Health College Alcohol Study surveys: 1993–2001. J Am Coll Health 2002;50:203–217. [PubMed: 11990979]

Weitzman ER. Poor mental health, depression, and associations with alcohol consumption, harm, and abuse in a national sample of young adults in college. J Nerv Ment Dis 2004;192:269–277. [PubMed: 15060400]

Wichstrom L, Pedersen W. Use of anabolic–androgenic steroids in adolescence: winning, looking good or being bad? J Stud Alcohol 2001;62:5–13. [PubMed: 11271964]

Yesalis CE. Epidemiology and patterns of anabolic–androgenic steroid use. Psychiatr Ann 1992;22:7–18.

Yesalis, CE.; Bahrke, MS.; Kopstein, AN.; Barsukiewicz, CK. Incidence of anabolic steroid use: a discussion of methodological issues. In: Yesalis, CE., editor. Anabolic Steroids in Sport and Exercise. 2. Human Kinetics; Champaign, IL: 2000. p. 305-332.

Yesalis CE, Kennedy NJ, Kopstein AN, Bahrke MS. Anabolic–androgenic steroid use in the United States. JAMA 1993;270:1217–1221. [PubMed: 8355384]

Yates WR, Perry PJ, MacIndoe J, Holman T, Ellingrod V. Psychosexual effects of three doses of testosterone cycling in normal men. Biol Psychiatry 1999;45:254–260. [PubMed: 10023498]

Table 1

Prevalence and trends in non-medical use of anabolic steroids among U.S. college students (weighted estimates)

	1993 (*n* = 15282) % (S.E.)	**1997 (*n* = 14428) % (S.E.)**	**1999 (*n* = 13953) % (S.E.)**	**2001 (*n* = 10904) % (S.E.)**
Lifetime anabolic steroid use				
Overall	0.86 (0.10)	0.95 (0.09)	0.97 (0.13)	1.05 (0.13)
Female	0.25 (0.06)	0.21 (0.05)	0.25 (0.05)	0.25 (0.07)
Male	1.52 (0.18)	1.75 (0.20)	1.80 (0.26)	1.99 (0.28)
12-month anabolic steroid use				
Overall	0.21 (0.04)	0.33 (0.05)	0.37 (0.07)	0.46 (0.08)[a]
Female	0.08 (0.03)	0.05 (0.03)	0.09 (0.03)	0.09 (0.04)
Male	0.36 (0.08)	0.65 (0.10)	0.68 (0.14)	0.90 (0.18)[a]
30-day anabolic steroid use				
Overall	0.10 (0.03)	0.16 (0.03)	0.16 (0.04)	0.16 (0.05)
Female	0.04 (0.02)	0.01 (0.01)	0.04 (0.02)	0.05 (0.03)
Male	0.16 (0.06)	0.31 (0.07)	0.29 (0.07)	0.30 (0.10)

[a] 12-month anabolic steroid use rates between 1993 and 2001 are significantly different from each other, after applying a Bonferroni correction ($p < 0.0083$). No other significant pair-wise comparisons were observed.

Table 2

Multivariate HGLM analyses of lifetime non-medical use of anabolic steroids (weighted estimates)

	1993 (*n* = 14610)	**1997 (*n* = 13714)**	**1999 (*n* = 13143)**	**2001 (*n* = 10552)**
Student (Level 1) characteristics	AOR (95% CI)[a]	AOR (95% CI)[a]	AOR (95% CI)[a]	AOR (95% CI)[a]
Sex				
Female	—	—	—	—
Male	5.34 (3.27, 8.72)**	8.52 (4.99, 14.54)**	6.42 (3.85, 10.72)**	7.42 (3.70, 14.91)**
Marital status				
Never married	—	—	—	—
Married	1.68 (0.95, 2.94)	1.11 (0.55, 2.24)	2.30 (1.08, 4.94)*	3.02 (1.35, 6.78)**
Age				
Under 21	—	—	—	—
21–23	1.55 (0.93, 2.58)	1.35 (0.84, 2.17)	1.22 (0.75, 1.98)	1.02 (0.57, 1.80)
Over 23	2.08 (1.02, 4.24)*	3.28 (1.68, 6.92)**	0.72 (0.38, 1.36)	1.24 (0.52, 2.95)
Intercollegiate athletics				
Non-athlete	—	—	—	—
Athlete	2.43 (1.56, 3.78)**	1.80 (1.20, 2.70)**	1.63 (1.04, 2.55)*	1.82 (1.06, 3.12)*
College (Level 2) characteristics				
Commuter status				
Non-commuter school	—	—	—	—
Commuter school	0.41 (0.16, 1.02)	0.96 (0.49, 1.87)	1.94 (1.19, 3.18)**	2.31 (1.07, 4.97)*
Estimated variance of college intercepts[b]	0.20	0.05	0.24*	0.83**

Symbol (–) denotes reference category.

* $p < 0.05$.

** $p < 0.01$.

[a] Odds ratios are adjusted for all predictors in the models, which include the student-level characteristics of sex, race, marital status, age, living arrangement, fraternity/sorority membership, grade point average, and sports participation, and the college-level characteristics of urbanization, geographical region, commuter status, school enrollment size, NCAA athletic division, admissions criteria and public/private status. The results for variables not significantly associated with lifetime non-medical use of anabolic steroids *in at least two years* are not shown ($p > 0.05$).

[b] The *p*-values indicated for the variance components are based on chi-square statistics computed by the HLM software for testing the null hypothesis that a given variance component is equal to zero (Raudenbush and Bryk, 2002).

Table 3

Associations between lifetime non-medical use of anabolic steroids and other risky behaviors, 2001 (weighted estimates)

Risky behaviors	Lifetime non-medical use[a] % (S.E.)	No lifetime non-medical use[a] % (S.E.)	Rao–Scott chi-square(d.f.), *p*-value	Adjusted OR (95% CI) [b]
Tobacco and alcohol use				
Cigarette use in the past 30 days	34.51 (5.81)	25.51 (0.84)	2.92 (1), $p = 0.09$	1.72 (1.02, 2.89)*
Binge drinking in past 2 weeks	72.46 (4.43)	40.18 (1.48)	30.27 (1), $p < 0.01$	3.83 (2.00, 7.34)**
Frequent binge drinking in past 2 weeks	46.02 (6.28)	17.65 (0.93)	35.67 (1), $p < 0.01$	3.53 (1.86, 6.72)**
30-day illicit/non-medical use of drugs				
Marijuana	33.36 (5.95)	16.72 (0.73)	12.81 (1), $p < 0.01$	2.74 (1.57, 4.79)**
Cocaine	17.69 (4.88)	1.70 (0.19)	78.97 (1), $p < 0.01$	11.59 (5.34, 25.15)**
Ecstasy	10.52 (4.19)	1.02 (0.12)	44.26 (1), $p < 0.01$	9.01 (3.88, 20.92)**
Other illicit drugs[c]	14.55 (4.84)	1.64 (0.17)	51.14 (1), $p < 0.01$	9.25 (4.19, 20.43)**
Prescription tranquilizers[d]	14.35 (4.09)	1.45 (0.16)	83.25 (1), $p < 0.01$	11.11 (5.63, 21.94)**
Prescription sedatives[d]	17.25 (5.09)	1.14 (0.14)	121.57 (1), $p < 0.01$	15.53 (6.95, 34.69)**
Prescription stimulants[d]	24.26 (5.99)	1.97 (0.23)	116.91 (1), $p < 0.01$	15.05 (6.81, 33.26)**
Prescription opioids[d]	14.68 (4.83)	2.79 (0.22)	26.44 (1), $p < 0.01$	5.23 (2.32, 11.79)**
12-month illicit/non-medical use of drugs				
Marijuana	53.83 (6.02)	29.47 (1.04)	18.55 (1), $p < 0.01$	2.88 (1.67, 4.98)**
Cocaine	35.84 (6.09)	3.96 (0.29)	149.78 (1), $p < 0.01$	12.97 (6.97, 24.13)**
Ecstasy	24.82 (5.96)	4.58 (0.32)	50.32 (1), $p < 0.01$	6.10 (3.32, 11.18)**
Other illicit drugs[c]	30.25 (6.04)	5.57 (0.35)	67.79 (1), $p < 0.01$	6.87 (3.87, 12.18)**
Prescription tranquilizers[d]	26.24 (5.65)	4.36 (0.33)	73.07 (1), $p < 0.01$	7.74 (4.42, 13.55)**
Prescription sedatives[d]	25.91 (6.13)	3.20 (0.29)	81.76 (1), $p < 0.01$	9.66 (4.90, 19.03)**
Prescription stimulants[d]	37.27 (6.50)	3.95 (0.40)	160.82 (1), $p < 0.01$	15.06 (7.66, 29.61)**
Prescription opioids[d]	37.82 (5.99)	7.01 (0.39)	90.10 (1), $p < 0.01$	7.78 (4.24, 14.27)**
At least one drug	76.82 (4.48)	32.35 (1.05)	83.03 (1), $p < 0.01$	7.93 (4.54, 13.86)**
30-day risky behaviors				
Drove after binge drinking	43.82 (7.32)	10.49 (0.71)	52.38 (1), $p < 0.01$	6.20 (3.32, 11.58)**
Rode as passenger with a drunk driver	56.70 (7.23)	22.80 (0.89)	31.51 (1), $p < 0.01$	4.90 (2.56, 9.38)**
Drove after drinking alcohol	61.80 (6.10)	28.62 (1.16)	34.62 (1), $p < 0.01$	3.95 (2.24, 6.95)**
Substance abuse/mental health				
12-month DSM-IV alcohol abuse[e]	47.43 (5.34)	31.59 (1.04)	9.74 (1), $p < 0.01$	1.71 (1.07, 1.51)*
12-month DSM-IV alcohol dependence[e]	21.14 (4.66)	6.24 (0.30)	29.63 (1), $p < 0.01$	3.08 (1.66, 5.70)**
First alcohol intoxication <16 years-old	48.39 (5.56)	19.22 (0.67)	44.88 (1), $p < 0.01$	4.12 (2.58, 6.59)**
30-day SF-36 mental health subscale (0–38)[e]	3.83 (1.90)	3.75 (0.18)	NS	NS

NS: not significant.

* $p < 0.05$.

** $p < 0.01$.

[a] Sample sizes for lifetime non-medical use ranged from 85 to 88 and no lifetime non-medical use ranged from 10,705 to 10,762.

[b] The reference group for each model was students who did not report non-medical use of anabolic steroids. The odds ratios in the weighted logistic regression models were estimated in HLM and adjusted for gender, race, age, marital status, living arrangement, grade point average, intercollegiate athletic status, geographical region, commuter status, and urbanicity (rural/small town). The results for these variables were not shown. The 95% CIs are based on robust standard errors calculated by HLM.

[c] Other illicit drugs include heroin, LSD, and other psychedelics.

[d] Non-medical use of prescription drugs refers to any use not under a doctor's orders.

[e] DSM-IV alcohol abuse, DSM-IV alcohol dependence and SF-36 mental health indicators were based on the 1999 CAS data; sample sizes for lifetime non-medical use ranged from 114 to 115 and no lifetime non-medical use ranged from 13,569 to 13,639.