

Nutritional Supplementation and Anabolic Steroid Use in Adolescents

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ABSTRACT

HOFFMAN, J. R., A. D. FAIGENBAUM, N. A. RATAMESS, R. ROSS, J. KANG, and G. TENENBAUM. Nutritional Supplementation and Anabolic Steroid Use in Adolescents. *Med. Sci. Sports Exerc.*, Vol. 40, No. 1, pp. 15–24, 2008. **Purpose:** To examine nutritional supplementation and anabolic steroid (AS) use in adolescent males and females in a multistate, cross-regional study. A secondary purpose of the study was to investigate the knowledge, beliefs, and sources of education on nutritional supplementation and AS in these students. **Methods:** A confidential self-report survey was administered to 3248 students representing grades 8–12 in 12 states in the continental United States by their teachers during homeroom or physical education class. **Results:** Use of at least one supplement was reported by 71.2% of the adolescents surveyed. The most popular supplements used were multivitamins and high-energy drinks. The use of supplements to increase body mass and strength, and to reduce body fat or mass, increased across grade and was more prevalent in males than females. The number of students that self-reported AS use was 1.6% (2.4% males and 0.8% females). The number of supplements used was related to AS use among adolescents, and this effect was greater among males. Adolescents also seemed willing to take more risks with supplements to achieve their fitness or athletic goals, even if these risks reduced health or caused premature death. **Conclusion:** This study demonstrates that reliance on nutritional supplements increases as adolescents mature. The apparent willingness of adolescents to use a supplement that may harm their health or shorten their life highlights the need for greater involvement of teachers, coaches, and physicians to provide continued education on the risks and benefits associated with nutritional supplementation and AS use. **Key Words:** ERGOGENIC AIDS, DRUG USE, RISKY BEHAVIOR, ANDROGENS, CHILDREN

For the past 50 yr, the use of nutritional supplements and anabolic steroids (AS) by athletes has increased the media's scrutiny and the medical and scientific focus on the efficacy and dangers of these substances. The medical risks associated with many of these ergogenic aids, as well as ethical considerations, have led the major sport governing bodies to initiate measures to combat their use. Many of these organizations have defined lists of drugs and methods that are banned from use by their athletes, and whose detection would result in suspension from competition. In addition, sports medicine and sport science organizations have begun to develop educational and awareness programs for their membership on AS and other

performance-enhancing substances. Despite known side effects and potential risks associated with many of these ergogenic aids, including the risk of being barred from competition, athletes still continue to use these substances and search for ways to mask their use to avoid detection.

Recent surveys have suggested that AS use and other banned performance-enhancing drugs commonly used by athletes may be declining compared with use patterns of two to three decades ago. In a survey of almost 14,000 NCAA student athletes, the NCAA has reported that the prevalence of AS and amphetamine use has declined in the past 12 yr (13). According to their results, AS use among athletes surveyed has actually decreased from 4.9% in 1989 to 1.4% in 2001, and additional reports have indicated that AS use among NCAA football players has decreased by almost 50% from 1985 to 1991 (11). Similar trends have also been reported in high school students. Early studies examining adolescent steroid use reported that AS use at the secondary level ranged from 6% (5) to 11% in males (18). In the past 10 yr, however, the use of AS at the high school level seems to be lower, with ranges varying from 3% (8) to 5.4% (17). Despite the apparent decline in AS use, NCAA surveys have shown that initial AS use in collegiate athletes is occurring earlier in the athlete's career, with the majority

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(> 40%) of these athletes first using AS during high school (13). In addition, a greater number of nonathletic males and females (2.9%) seem to be using AS (8), and recent reports suggest that AS use has also trickled into the middle schools (9). These trends suggest that the educational process of combating AS use may not have successfully targeted the adolescent population.

The apparent decrease in the use of AS and other banned drugs does not seem to have reduced the use of performance-enhancing substances. Recent reports indicate that between 65 and 89% of intercollegiate athletes are using some type of nutritional supplement (11,15), and similar use patterns may also be occurring at the scholastic level. A recent study of high school football players has reported that 31% of the athletes surveyed use some performance-enhancing supplement, with 13% of the athletes admitting to taking more than one supplement (25). Performance-enhancing substances can be generally divided into two categories: hormones and the drugs that mimic their effects (these are generally banned by sports governing bodies), and dietary or nutritional supplements. Whether the prevalence of nutritional supplementation in a high school student will lead to the use of banned substances is not known, but a pressing issue is whether these students are receiving the proper information concerning nutritional supplementation.

Despite an apparent decline in reported AS use, recent media exposure involving tragic cases of high school students dying from AS, congressional hearings on AS testing in professional sports, and allegations of current widespread use in Major League Baseball have led the validity of these claims to be questioned. A major concern for many is the apparent abuse of AS in the adolescent population for both athletic and aesthetic reasons. The medical issues associated with AS use may be much greater in this population than in an adult population (16). The knowledge base of these adolescents may also be lower than the adult population, lessening the ability of these individuals to make educated decisions. In addition, the alleged abuse of AS by professional athletes has raised issues concerning the influence that these athletes may have on the adolescent population, who often idolize these athletes. However, the scientific literature concerning the impact that professional athletes have on adolescent steroid or nutritional supplementation use is limited. The debate on AS abuse in athletes raises issues concerning perceptions of whether adolescents believe that AS can help achieve athletic goals, and whether professional athletes need or have the right to use AS. Thus, the purposes of this study were threefold. The primary objective was to examine the nutritional supplementation and AS habits in high school (8th–12th grade) students. Additional objectives were to investigate the knowledge, beliefs (regarding self-administered AS use, AS use among peers, and AS use in professional athletes), and sources of education on nutritional supplementation and AS of these students, and to

compare beliefs and sources of education between AS users and nonusers.

METHODS

Participants. Three thousand two hundred forty-eight students, representing grades 8–12 in 12 states within the continental United States, were surveyed. The survey was conducted in the 2005–2006 academic year. Males represented 48% (1559) of the population surveyed, and females accounted for the remaining 52% (1689). The number of students surveyed per state can be seen in Table 1. The institutional review board at the College of New Jersey approved the research protocol. To be eligible to complete the survey, subjects were required to have a signed parental consent, or if they were 18 or older, they were permitted to provide their own informed consent. Surveys were provided to 7150 students, and 45% of the students returned signed consents. It is not known whether lack of compliance was attributable to parents not providing consent, or whether the students failed to bring the surveys home for consent. All surveys were completed by the students in their school. Either the student's homeroom teacher or health and physical education instructor distributed the survey to all students who had returned the signed parental consent or informed consent. Of the students returning parental or informed consents, 98.3% completed the questionnaires. Subjects not completing questionnaires were unable to, for a variety of reasons, such as absence on day of survey administration, or unwillingness to participate.

Survey procedure. Students were advised that the questionnaire was strictly confidential. Before administering the questionnaire, a brief explanation was provided about the purpose of the study, requirements, and procedures. Students were then provided with parental consent forms, with instructions to parents concerning the study's purpose, importance, and procedure. A week later, all students who had returned signed parental consents were permitted to complete the survey. Students were instructed not to write their names or any other identifying marks on the questionnaire. On completion of the questionnaire, the student folded the survey in half and placed it in an

TABLE 1. Subject representation per state.

| State | Number of Subjects | Percentage of Total Subject Population |
|--------------|--------------------|--|
| New Jersey | 1073 | 33.0 |
| Pennsylvania | 844 | 26.0 |
| New Mexico | 361 | 11.1 |
| Iowa | 271 | 8.3 |
| Wisconsin | 195 | 6.0 |
| Connecticut | 95 | 2.9 |
| Missouri | 87 | 2.7 |
| Ohio | 85 | 2.6 |
| Colorado | 82 | 2.5 |
| New York | 75 | 2.3 |
| Minnesota | 41 | 1.3 |
| California | 39 | 1.3 |

unmarked envelope provided to the teacher. The envelope was sealed and placed by the teacher in a box held by the survey coordinator at the school. All surveys from that school were then mailed to study investigators.

Survey instrument. The survey consisted of 42 questions focusing on demographic information (e.g., age, grade, gender), nutritional supplement use, beliefs and attitudes towards AS, and primary sources of education for nutrition and AS. Questions concerning nutritional supplement and AS use specifically asked each subject to indicate whether “you take or have taken in the past.” Subjects had the following options: multivitamin, protein powder, amino acids, weight-gain powder, fat burners to lose weight, high-energy drinks, ephedra, caffeine pills, creatine, and AS. Regarding to primary sources of education for nutrition and AS, each subject was asked to indicate “where they get most of their information.” Subjects were provided 11 choices (teacher; friend/teammate; sibling; strength and conditioning coach; athletic trainer; books/magazines; sport coach; physician; Internet sites; parents; drug or supplement dealer) and asked to provide only one answer. The survey also asked questions concerning the students’ willingness to take a substance that may improve their fitness or athletic goals but negatively impact their health; the perceived impact of AS on health; the legality of AS; and the necessity of the use of AS for athletes competing at the collegiate and professional levels. Questions also focused on sports and exercise participation habits, such as frequency of exercise, type of exercise program, and number of hours per day exercising. Students were also asked to rate the intensity of their sports practice and fitness conditioning sessions with a 15-cm visual analog scale, with the verbal anchors *very*, *very easy* and *very, very hard* attached to the extremes of the scale. Students were asked whether they had ever used AS or nutritional supplements, how they were obtained, and reasons for their use. Students were also asked questions concerning the impact that AS use by professional athletes had on their own use or use by their friends.

Construct validity of the survey was determined by providing the questionnaire to a panel of physical education instructors, strength and conditioning professionals, exercise physiologists, and AS and nutritional supplement experts, to provide feedback on the appropriateness and relevance of the questions and the language and ability of the questions to be comprehended by students in the 8th–12th grades. Revisions to the survey questions were made to satisfy any concerns that had been posed by the panel. A pilot study was then conducted to determine the internal validity of the survey instrument. A group of 24 high school students in the 9th–12th grades were randomly selected to participate in the pilot study. The purpose and procedure of the study were explained to the subjects, and the length of time needed to complete the survey was monitored. Cronbach’s alpha was used to estimate internal reliability, which was determined to be 0.84.

TABLE 2. Nutritional supplement and anabolic steroid use in adolescent male and female students.

| Supplement | Percent (%) Saying Yes to Source | | | | | | | | | | | | | | |
|----------------------------|----------------------------------|------|------|-----------|------|------|------------|------|------|------------|------|------|------------|------|------|
| | 8th Grade | | | 9th Grade | | | 10th Grade | | | 11th Grade | | | 12th Grade | | |
| | M | F | T | M | F | T | M | F | T | M | F | T | M | F | T |
| <i>N</i> | 222 | 298 | 520 | 298 | 369 | 667 | 320 | 332 | 652 | 467 | 459 | 926 | 239 | 220 | 459 |
| Multivitamin | 65.8 | 62.1 | 63.7 | 54.0 | 53.9 | 54.0 | 58.8 | 56.0 | 57.4 | 57.4 | 64.1 | 60.7 | 65.3 | 58.6 | 62.1 |
| Protein powder | 8.6 | 3.3 | 5.6 | 22.5 | 1.6 | 10.9 | 33.4 | 3.9 | 18.4 | 32.6 | 4.4 | 18.6 | 39.8 | 2.3 | 21.8 |
| Amino acids | 1.8 | 0.3 | 1.0 | 12.1 | 0.8 | 5.9 | 13.4 | 0.9 | 7.1 | 14.1 | 1.1 | 7.7 | 19.7 | 1.8 | 11.1 |
| Weight gain powder | 1.8 | 1.0 | 1.3 | 5.0 | 1.4 | 3.0 | 9.4 | 1.5 | 5.4 | 12.4 | 2.0 | 7.2 | 14.2 | 0.9 | 7.8 |
| Fat burners to lose weight | 5.9 | 4.4 | 5.0 | 4.7 | 8.9 | 7.1 | 3.1 | 9.0 | 6.1 | 7.5 | 11.1 | 9.3 | 8.4 | 18.6 | 13.3 |
| High-energy drinks | 39.2 | 20.1 | 28.5 | 40.3 | 24.1 | 31.3 | 40.9 | 27.8 | 34.2 | 35.6 | 27.7 | 31.6 | 36.4 | 25.5 | 31.2 |
| Ephedra | 0.5 | 0.7 | 0.6 | 2.6 | 4.3 | 3.6 | 1.6 | 2.1 | 1.8 | 3.4 | 2.4 | 2.9 | 4.6 | 6.8 | 5.7 |
| Caffeine pills | 0.9 | 1.0 | 1.0 | 4.7 | 3.5 | 4.1 | 5.3 | 3.3 | 4.3 | 5.8 | 3.3 | 4.5 | 6.7 | 5.9 | 6.3 |
| Creatine | 0.9 | 0.3 | 0.6 | 7.7 | 1.4 | 4.2 | 14.1 | 0.6 | 7.2 | 14.6 | 0.7 | 7.7 | 22.2 | 1.4 | 12.2 |
| Anabolic steroids | 0 | 1.0 | 0.6 | 1.3 | 1.4 | 1.4 | 2.5 | 0.6 | 1.5 | 2.4 | 0.2 | 1.3 | 5.9 | 1.4 | 3.7 |

M, males; F, females; T, total.

Statistical analysis. To test gender, grade, and their interaction effects on nutritional supplement and AS use, binary logistic regressions were employed using each of the supplements and AS as dependent variable (DV), separately. Regression coefficients (B), their associated standard errors (SE), and odd ratios (OR) are reported when significance was met ($P < 0.05$), followed by descriptive percentage figures. Multiple analysis of variance (MANOVA) procedures, followed by between-subjects univariate tests, were employed to test gender, grade, and their interaction effect on supplements generally used to gain mass and strength (protein powder, amino acids, weight-gain powder, creatine), cause weight and fat reduction (fat burners, high-energy drinks, ephedra, caffeine pills), and total supplement use. Means and SD are provided to describe main and interaction effects. The relationship between supplements used to gain mass and strength (BM gain), reduce body fat and weight (BM reduction), total supplement use, and AS use was analyzed through logistic regression, using gender and gender \times BM gain/reduction as covariates. Multinomial regression was used to elicit gender, grade, and their interaction effect of sources of supplement use and AS use. Logistic regression was employed to test gender, grade, and their interaction effect on each of the beliefs associated with nutritional supplement use and AS use. Finally, χ^2 likelihood ratios (LR) were used to contrast AS users and nonusers on each of the belief questions. Percentages accompany significant effects, and general trends are described in percentages across age and gender. SPSS 14.0 was used for the statistical analyses.

RESULTS

General observations across age and gender.

Nutritional supplement and AS use by adolescent males and females is shown in Table 2. The reported use of at least one supplement was reported by 71.2% of the students surveyed. The most popular supplement used by adolescent males and females was multivitamins (59.3% of all adolescent males and females). The next-most-popular supplement consumed was high-energy drinks (31.5% of all adolescent males and females). The use of BM-gain supplements (protein powders, amino acids, weight-gain powders, and creatine) was reported by 17.3% of all students surveyed, and the use of BM-reduction supplements (fat burners, high-energy drinks, ephedra, caffeine pills) was reported by 35.1% of all students surveyed.

Nutritional supplementation and AS use by gender and grade. To test gender, grade, and gender \times grade interaction effects on nutritional supplementation and AS use, binary logistic regressions were employed for each of these variables; gender and grade were the independent variables, and each nutritional supplement and AS were the dependent variables, separately. Nonsignificant effects ($P > 0.05$) for gender, grade, and their interaction resulted for

multivitamin, amino acid, fat burners, ephedra, and caffeine pills. However, several significant main and interaction effects emerged. Grade effects were revealed for protein powder ($B = 0.65$, $SE = 0.14$, $P = 0.000$, $OR = 1:1.92$), weight-gain powders ($B = 0.80$, $SE = 0.22$, $P = 0.000$, $OR = 1:2.22$), high-energy drinks ($B = 0.19$, $SE = 0.09$, $P = 0.04$, $OR = 1:0.83$), creatine ($B = 0.87$, $SE = 0.25$, $P = 0.000$, $OR = 1:2.38$), and AS ($B = 1.32$, $SE = 0.38$, $P = 0.000$, $OR = 1:3.75$). Protein powder use increased from the 8th through 10th grades and elevated again in the 12th grade. The use of weight-gain powders by students increased from the 8th to 11th grades and remained constant in the 12th grade. The use of high-energy drinks increased from the 8th grade through 10th grade. The self-reported use of creatine and AS increased as students matured from the 8th to 12th grade. Gender effects were obtained for the use of high-energy drinks ($B = -1.95$, $SE = 0.60$, $P = 0.001$, $OR = 1:1.92$) and AS ($B = 6.56$, $SE = 2.60$, $P = 0.01$, $OR = 1:706.60$). Male adolescents used high-energy drinks and AS (38.2%) significantly more than females (25.3%) across all grades.

Grade \times gender effects were revealed for protein ($B = -0.29$, $SE = 0.11$, $P = 0.01$, $OR = 1:0.75$), weight-gain powder ($B = -0.36$, $SE = 0.17$, $P = 0.04$, $OR = 1:0.69$), high-energy drinks ($B = 0.13$, $SE = 0.06$, $P = 0.02$, $OR = 1:1.14$), and AS ($B = -0.73$, $SE = 0.26$, $P = 0.005$, $OR = 1:0.48$). The use of protein powders, weight-gain powders, and AS was significantly greater in males than females from the 9th to 12th grades. A 4.6-fold increase in the use of protein powder was seen between the 8th and 12th grades in males. The use of AS was self-reported by 1.6% of the total students surveyed (0.8% of all adolescent females and 2.4% of all adolescent males). The pattern of AS use increased as students moved to the higher grades, with approximately 6% of male 12th graders self-reporting AS use. This was greater than that seen at any other grade level, and more than 2.5-fold higher than that reported by males in the 11th grade. Differences in AS use patterns between males and females were seen in the 10th–12th grades. Males also consumed high-energy drinks at a higher rate than females at each grade level.

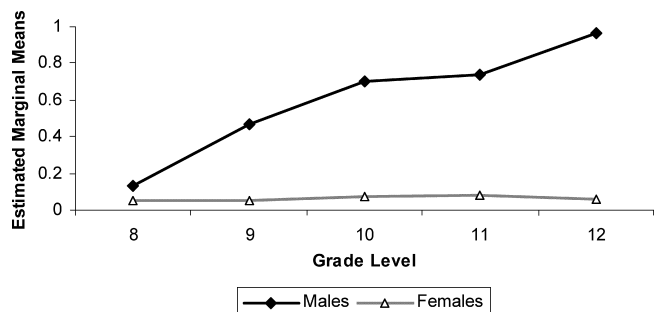


FIGURE 1—Estimated marginal means of the effect of grade and gender on supplements used for body mass and strength gains. Significant grade \times gender interaction.

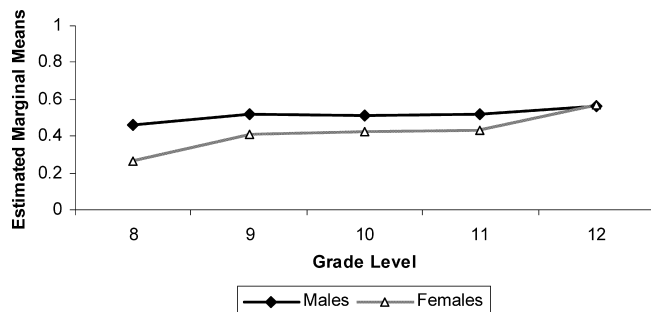


FIGURE 2—Estimated marginal means of the effect of grade and gender on supplements used for body mass and body fat reduction. Significant gender effect.

To analyze grade, gender, and grade \times gender interaction effects on the use of BM-gain and BM-reduction supplements, all single items were summed up and subjected to MANOVA followed by between-subjects tests. The analyses revealed a significant grade effect (Wilks' $\lambda = 0.97$, $F(8, 6426) = 11.85$, $P = 0.000$). Between-subject effects for BM gain and BM reduction were also significant ($F(4, 3214) = 22.79$, $P = 0.000$; and $F(4, 3214) = 4.49$, $P = 0.000$, respectively). The use of BM-gain supplements increased from the 8th grade (8.5%) to the 9th grade (24.0%), and it continued to increase in the 10th (38.0%), 11th (41.1%), and 12th grades (52.9%). The use of BM-reduction supplements also increased from the 8th grade (34.6%) to 9th grade (46.0%), but it remained at this level during grades 10 (46.5%) and 11 (47.4%) before increasing further in the 12th grade (56.4%). Gender effects were also significant (Wilks' $\lambda = 0.89$, $F(8, 3214) = 184.04$, $P = 0.000$), as were between-subject effects ($F(4, 3214) = 362.68$, $P = 0.000$; and $F(4, 3214) = 12.82$, $P = 0.000$, respectively). The use of BM-gain supplements by male adolescents was significantly greater than females (62.6% and 6.4%, respectively). Similarly, male adolescents also used nutritional supplements for BM reduction to a greater extent than females (51.7% and 41.1%, respectively). A gender \times grade interaction was significant (Wilks' $\lambda = 0.96$, $F(8, 6426) = 13.09$, $P = 0.000$), but this was seen for BM-gain supplements only (Fig. 1) ($F(4, 3214) = 20.02$, $P = 0.000$). No interactions were noted for BM reduction (Fig. 2) ($F(4, 3214) = 1.14$, $P = 0.33$). As male students mature from 8th to 12th grade, the number of supplements used to enhance muscle size and strength gains increases significantly, and these increases were significant compared with females' supplement use.

Analysis of total supplement use revealed significant grade ($F(4, 3214) = 17.74$, $P = 0.000$), gender ($F(1, 3224) = 200.15$, $P = 0.000$), and interaction ($F(1, 3224) = 4.84$, $P = 0.001$) effects. Figure 3 shows the significant grade and gender differences in the total number of supplements consumed by male and female adolescents. As adolescents matured, they tended to increase the use of nutritional supplements, and this was more prevalent in males than in females.

Influence of BM-gain/reduction and total supplements used on AS use, controlling for gender.

To examine the relationship between the use of BM-gain supplements, BM-reduction supplements, and total supplement use on the use of AS, a logistic regression analysis was employed. Three logistic regressions were performed regressing AS use onto (a) total supplements used, (b) BM-gain supplements, and (c) BM-reduction supplements while controlling for gender and gender \times supplementation interaction. The first regression, using total supplements consumed and gender on AS use, resulted in a significant total supplement \times gender interaction ($B = 0.42$, $SE = 0.19$, $P = 0.03$, $OR = 1:152$). Males tended to use more nutritional supplements than females, and males using a greater number of nutritional supplements were also more apt to use AS. The combination of total supplements and gender was correlated ($r = 0.37$, $P = 0.000$) to AS use. Similar results were obtained for BM-gain supplementation. Only the BM gain \times gender interaction was significant ($B = 0.98$, $SE = 0.31$, $P = 0.002$, $OR = 1:2.66$). The combination of BM gain and gender was correlated to AS use ($r = 0.39$, $P = 0.000$). The effect of supplements that produce body mass gains and strength improvements was stronger than the total supplements used on AS use, indicating that males who use these specific supplements tend to also use AS. Regressing BM-reduction supplements and gender on AS resulted in a main effect for BM reduction ($B = 1.28$, $SE = 0.33$, $P = 0.000$, $OR = 1.3,61$), indicating that across gender, the use of supplements designed to reduce body mass or body fat was positively related to AS use.

Sources of nutritional supplementation education.

The primary sources of education for adolescent males and females are illustrated in Table 3. Multinomial regression applied to the sources of educational information by gender and grade resulted in significant gender χ^2 ($df = 12$, $N = 3224$) = 84.49, likelihood ratio (LR) = 86.51, $\phi = 16$, $P = 0.000$ and grade (χ^2 ($df = 48$, $N = 3224$) = 199.48, $LR = 204.48$, $\phi = 25$, $P = 0.000$) effects. Teachers (36%) and parents (16.2%) were the primary sources of education concerning nutrition supplementation and AS use for adolescent males and females. Teachers were relied on more for 8th-grade males than for any other grade level.

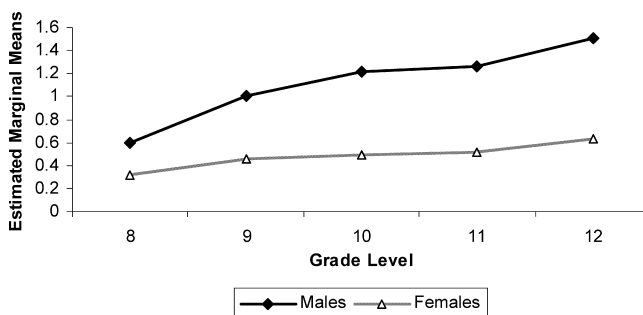


FIGURE 3—Estimated marginal means of the effect of grade and gender on total supplements used. Significant grade \times gender interaction.

TABLE 3. Primary source of education on nutrition.

| Source | Percent (%) Saying Yes to Source | | | | | | | | | |
|---------------------------------|----------------------------------|----------------------|--------------------|----------------------|--------------------|----------------------|--------------------|----------------------|--------------------|----------------------|
| | 8th Grade | | 9th Grade | | 10th Grade | | 11th Grade | | 12th Grade | |
| | Males (N = 222) | Females (N = 298) | Males (N = 303) | Females (N = 370) | Males (N = 323) | Females (N = 334) | Males (N = 469) | Females (N = 459) | Males (N = 239) | Females (N = 222) |
| Teacher | 36.9 | 27.5 | 19.8 | 22.7 | 23.5 | 25.1 | 22.4 | 24.6 | 19.7 | 19.4 |
| Friend or teammate | 0.9 | 0.3 | 2.3 | 0.8 | 2.2 | 1.2 | 4.1 | 1.3 | 3.3 | 2.3 |
| Sibling | 0.9 | 1.3 | 0.3 | 1.1 | 0.6 | 1.5 | 2.1 | 2.4 | 1.7 | 0.5 |
| Strength and conditioning coach | 0.0 | 0.7 | 1.7 | 0.5 | 2.8 | 0.9 | 3.2 | 0.7 | 2.5 | 0.9 |
| Athletic trainer | 1.4 | 0.7 | 2.6 | 1.1 | 5.9 | 2.7 | 4.5 | 3.5 | 7.1 | 3.6 |
| Books and magazines | 0.5 | 3.0 | 3.0 | 7.6 | 4.3 | 5.4 | 5.8 | 7.8 | 7.5 | 9.0 |
| Sport coach | 3.6 | 2.3 | 3.3 | 2.7 | 3.7 | 4.5 | 7.7 | 6.3 | 5.4 | 2.3 |
| Physician | 6.3 | 9.1 | 9.6 | 11.1 | 5.9 | 11.1 | 6.6 | 9.2 | 4.2 | 8.6 |
| Internet sites | 1.8 | 1.3 | 3.3 | 1.4 | 6.5 | 3.3 | 3.6 | 2.0 | 4.2 | 5.0 |
| Parents | 24.3 | 27.5 | 13.9 | 19.7 | 13.9 | 15.6 | 12.4 | 20.7 | 10.0 | 13.1 |

However, females tended to maintain a similar reliance on teachers throughout high school. The use of parents as an educational source decreased by more than 50% as students reached the 12th grade. Females tended to rely more on their parents (20.7%) as an education source than did males (12.4%) in the 11th grade. A greater dependence on friends, coaches, athletic trainers, and Internet sites to provide nutritional information seemed to replace the students' reliance on their parents as they matured. Males tended to rely on their strength and conditioning coaches more than females did.

Beliefs associated with nutritional supplementation and AS use. The beliefs of adolescent males and females on AS use are presented in Table 4. Logistic regression analysis indicated significant grade effects on the willingness of males and females to use a pill or powder to improve their fitness goals ($B = 0.37$, $SE = 0.10$, $P = 0.000$, $OR = 1:1.45$). Adolescents' willingness to take a supplement, even one that may harm their health ($B = 0.46$, $SE = 0.17$, $P = 0.008$, $OR = 1:1.59$) or shorten their life ($B = 0.49$, $SE = 0.19$, $P = 0.01$, $OR = 1:1.64$), also increased from the 8th to 12th grades. Significant grade effects were

also noted in the belief that high school students use AS, and the belief that AS can help achieve athletic dreams. In addition, significant grade effects were also seen in the belief that professional athletes need AS to help improve sports performance, and the belief that professional athletes have the right to take AS. Significant differences for grade were also seen in the belief that AS is considered cheating.

Significant gender effects were seen in the belief that high school students use AS, and whether professional athletes have the right to use AS. Grade \times gender interactions ($B = -0.29$, $SE = 1.31$, $P = 0.03$, $OR = 1:0.75$) were seen in the willingness of males and females to take a pill or powder that may shorten their lives. Males seem more willing to take this risk than females. Males in the 12th grade were 3.7 times more willing than females to take a supplement that might shorten their life. Approximately 3% of both males and females in the 8th grade indicated that they were willing to take a supplement that might shorten life. However, as students reached the 12th grade, the willingness of females to take such a supplement remained the same, whereas 8.6% of the male students in that grade indicated that they were willing to use a supplement that might provide them the

TABLE 4. Beliefs on anabolic steroid use in adolescent male and female students.

| Belief | Percent (%) Saying Yes to Question | | | | | | | | | |
|--|------------------------------------|------|-----------|------|------------|------|------------|------|------------|------|
| | 8th Grade | | 9th Grade | | 10th Grade | | 11th Grade | | 12th Grade | |
| | M | F | M | F | M | F | M | F | M | F |
| <i>N</i> | 222 | 298 | 303 | 370 | 323 | 334 | 469 | 459 | 239 | 222 |
| I may be willing to take a pill or powder if it guarantees that I will reach my fitness goals. | 15.8 | 7.0 | 27.7 | 14.3 | 35.9 | 16.2 | 39.6 | 19.2 | 45.6 | 23.4 |
| I may be willing to take a pill or powder if it guarantees that I will reach my fitness goals, even though it may harm my health. | 3.2 | 2.3 | 6.6 | 5.1 | 8.4 | 6.0 | 11.0 | 5.2 | 14.7 | 8.6 |
| I may be willing to take a pill or powder if it guarantees that I will reach my fitness goals, even though it may shorten my life. | 3.2 | 3.0 | 5.6 | 5.7 | 6.2 | 3.3 | 7.1 | 3.9 | 8.6 | 2.3 |
| Do you think that AS can improve your sports performance? | 50.5 | 28.9 | 42.6 | 22.4 | 53.5 | 29.6 | 55.1 | 25.3 | 53.7 | 29.3 |
| Do you think that high school students use AS? | 81.1 | 83.2 | 74.9 | 81.4 | 85.6 | 83.5 | 87.8 | 80.6 | 90.1 | 78.8 |
| Do you think that middle school students use AS? | 31.5 | 31.9 | 40.3 | 43.2 | 48.0 | 43.7 | 45.4 | 35.7 | 35.4 | 40.1 |
| Do professional athletes need AS to help improve sports performance? | 10.4 | 5.4 | 12.2 | 10.2 | 12.7 | 6.0 | 15.4 | 7.2 | 18.8 | 10.4 |
| Do you think that AS are dangerous to your health? | 97.3 | 96.6 | 89.4 | 92.7 | 96.4 | 95.5 | 92.5 | 95.0 | 90.8 | 89.2 |
| Do you think that AS are legal? | 25.2 | 26.5 | 33.7 | 31.9 | 28.9 | 24.6 | 27.5 | 29.8 | 26.4 | 24.3 |
| Do you think that AS can help achieve your athletic dreams? | 41.0 | 21.8 | 28.3 | 23.8 | 44.8 | 29.0 | 49.9 | 23.3 | 47.3 | 26.1 |
| Do you think that AS can help achieve a college scholarship? | 22.5 | 13.4 | 21.1 | 10.8 | 30.0 | 17.4 | 36.7 | 17.0 | 36.4 | 17.6 |
| Do professional athletes influence your decision to use AS? | 19.8 | 13.4 | 22.1 | 22.7 | 23.5 | 20.1 | 18.6 | 18.1 | 20.1 | 21.2 |
| Do professional athletes influence your friends' decision to use AS? | 32.4 | 30.2 | 36.6 | 46.5 | 40.6 | 44.3 | 43.9 | 44.0 | 46.0 | 49.1 |
| Do you think that taking AS is cheating? | 93.2 | 92.3 | 85.5 | 85.9 | 86.7 | 92.2 | 87.4 | 91.7 | 82.8 | 86.5 |
| Do professional athletes have the right to take AS? | 9.0 | 12.1 | 14.9 | 11.1 | 13.0 | 8.7 | 15.1 | 8.3 | 18.4 | 11.3 |

AS, anabolic steroids; M, males; F, females.

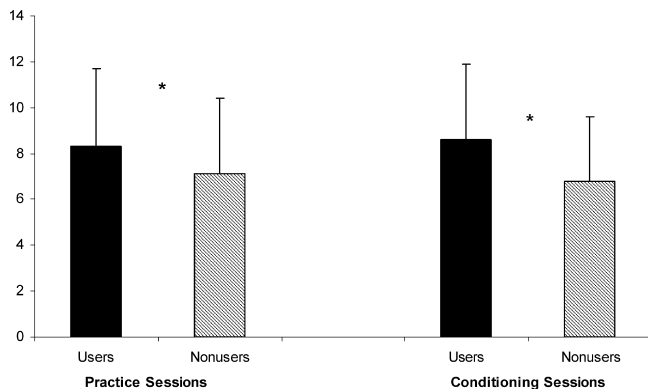


FIGURE 4—Ratings of intensity on average of sports practice and fitness conditioning sessions. * $P < 0.05$ between users and nonusers.

ability to reach their athletic dreams, but at the expense of a shortened life span. A significant grade \times gender interaction was also seen in the belief that high school students use AS. Between 75 and 90% of the students surveyed indicated that high school students use AS, but 11th- and 12th-grade males believed that such use was greater than did their female classmates. In addition, significant grade \times gender interactions were noted for the beliefs that AS use is cheating and the belief that professional athletes have the right to use AS. Males tended to believe that professional athletes have the right to take AS, and this belief increased as males matured from the 8th to 12th grades. Females tended to be consistent in their belief that professional athletes have the right to use AS. The largest differences appeared in the 11th grade.

Comparisons between AS users and nonusers.

Approximately 98% of adolescents who self-admit to using or having used AS participate in an exercise program at more than twice the rate of nonusers (43.6%). The three primary goals of the fitness programs for AS users were to look better (78.7%), get stronger (74.5%), and become bigger (72.3%). The three fitness and conditioning goals for nonusers were to look better (68.0%), feel better (66.8%), and get stronger (63.6%). The desire to increase muscle size was almost twice as common in AS users as in nonusers. AS users also reported a significantly higher intensity of exercise compared with nonusers (Fig. 4). In addition, the average number of hours of exercise per day was significantly greater in AS users than in nonusers (Fig. 5).

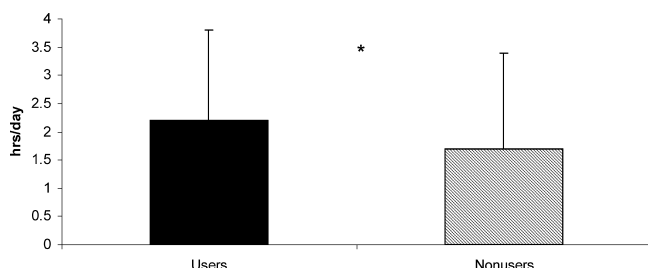


FIGURE 5—Average hours of exercise per day between anabolic steroid users and nonusers. * $P < 0.05$ between users and nonusers.

TABLE 5. Beliefs on anabolic steroid use: comparison of users vs nonusers.

| Belief | Percent (%) Saying Yes to Question | |
|--|------------------------------------|----------|
| | Users | Nonusers |
| I may be willing to take a pill or powder if it guarantees that I will reach my fitness goals. | 83.0 | 24.3* |
| I may be willing to take a pill or powder if it guarantees that I will reach my fitness goals, even though it may harm my health. | 64.7 | 6.2* |
| I may be willing to take a pill or powder if it guarantees that I will reach my fitness goals, even though it may shorten my life. | 56.9 | 4.2* |
| Do you think that AS can improve your sports performance? | 76.5 | 39.0* |
| Do you think that high school students use AS? | 90.2 | 84.5 |
| Do you think that middle school students use AS? | 56.9 | 41.2* |
| Do professional athletes need AS to help improve sports performance? | 41.7 | 10.5* |
| Do you think that AS are dangerous to your health? | 63.3 | 96.6* |
| Do you think that AS are legal? | 60.0 | 28.9* |
| Do you think that AS can help achieve your athletic dreams? | 80.4 | 34.8* |
| Do you think that AS can help achieve a college scholarship? | 68.0 | 22.4* |
| Do professional athletes influence your decision to use AS? | 57.1 | 11.7* |
| Do professional athletes influence your friends' decision to use AS? | 63.3 | 43.4* |
| Do you think that taking AS is cheating? | 38.8 | 91.8* |
| Do professional athletes have the right to take AS? | 57.1 | 11.7* |

AS, anabolic steroids. * Significant difference between users and nonusers.

Comparisons between AS users and nonusers on beliefs towards AS use are presented in Table 5. AS users and nonusers were compared with each other on each of the AS belief questions, using χ^2 and LR statistics. Significant differences in all beliefs were seen between users and nonusers, except the perception of AS use among high school students. Users and nonusers agreed that AS use does occur in high school students. Interestingly, examining differences between AS users and nonusers on the primary source of education, teachers were the primary source of education on nutrition and AS for nonusers, whereas AS users reported using multiple sources for their information, with Internet sites seeming to provide the most popular source.

DISCUSSION

Our results confirm earlier findings that nutritional supplementation and AS are commonly used among adolescents and that use increases with age. AS use among adolescents seen in this study seemed to be lower than that previously reported, contrasting with a public perception that AS use is on the rise. Our results also indicate that students were more willing to use a supplement to achieve their fitness goals, even at the expense of their health and a shortened life. Males seemed almost twice as willing to take these risks as were females.

Dietary supplement use in adolescent populations has been reported to range from 23 to 32% in recent National Health and Nutrition Examination surveys (3). Other investigators

have indicated that supplement use among adolescents may even be higher, with reports ranging between 42 and 74% of students surveyed (2,14). The results of this study seem to support the higher supplementation rates of adolescent students. Supplementation habits of male and female adolescents seemed to differ. Male adolescents seemed to be more interested in supplements that increased muscle size, strength, and body mass than were female adolescents. The tendency for males to supplement with protein, amino acids, weight-gain powders, and creatine increased from the middle school grades (8th and 9th grade) to the upper grades of high school. Interestingly, no changes in the percentages of male adolescents using protein or weight-gain powders are seen once they enter high school (10th grade). However, the use pattern of creatine, amino acids, and AS in 12th-grade males is greater than any of the younger grades. Interestingly, the use patterns of supplements that are more likely to be used to control or reduce body mass and body fat (e.g., fat burners, ephedra, and caffeine pills) were more commonly used by males. These results contrast those of other studies indicating that female adolescents are more likely to supplement with weight-control products, whereas male adolescents seem to favor muscle-building supplements (2,7,10).

An interesting finding of this study was the relationship seen between nutritional supplement and AS use. Logistic regression analysis indicated that the more supplements that are consumed by adolescents, the greater the likelihood that those students will use AS. This effect was more pronounced with the intake of supplements that are generally used to increase body mass and strength. These effects were even stronger in male adolescents. However, these results can also be interpreted as indicating that adolescents who use AS are also using a number of other nutritional supplements. This latter explanation seems to have support in the literature, with recent studies reporting on the polypharmacy associated with AS use in adults (22). Although this study is unable to provide the direction that this relationship occurs (i.e., whether increased use of nutritional supplements increases the likelihood of AS use, or whether adolescents who use AS likely use many other supplements), it does provide a stimulus for further research examining the affect of nutritional supplement use in adolescents "opening the gate" for the potential use of banned substances.

The number of students admitting to AS use in this study supports a trend towards a lowering of AS use by adolescents seen during the past 20 yr. Early studies reported that adolescent AS use ranged from 6 to 11% (7,20), but recent investigations suggest that AS use may be lower (ranging from 1.6 to 5.4%) (7,8,17,21,23,26). Studies showing a higher incidence (> 6% self-admitting) of use have specifically examined high school football players (24). The results of this study also do not support the magnitude of AS use previously reported in middle school students (9,25), despite 30 to 48% of the students surveyed believing that middle school students use AS. In addition, although AS use in

female adolescents has been reported as having dramatically increased in the past few years (17), the results of this study do not support these claims, suggesting instead that the trend towards greater AS use among female adolescents may have been overstated.

The decrease in AS use among adolescent students may be attributed to several factors related to education and viable alternatives to substitute for illegal drug use. Success has been achieved in using peer pressure to educate high school athletes on behaviors designed to reduce the intent to use AS (12). In addition, the increased use of creatine as an ergogenic aid for enhancing lean tissue accretion and strength/power gains may provide a relatively safe and efficacious alternative to AS, although the studies examining its use in the adolescent population have been quite limited. Reports suggest that 48% of male collegiate athletes use or have used creatine during preparation for competition, and such use may approach more than 80% in certain strength/power sports (19). In addition, creatine has also gained popularity among high school athletes, with 90% of athletes who report supplementing choosing to use creatine (26). The self-reported use of creatine seen in this study (22.2% of 12th-grade males) seems to confirm the popularity of this supplement among male adolescents. Still, the approximately 6% self-reported AS use in 12th-grade males is still alarming and does suggest that greater efforts for providing a more comprehensive education program are necessary, rather than just viable supplement alternatives.

The greatest source of information for the adolescents surveyed in this study was their teachers and parents. This was expected, considering that the subjects were all students, and teachers were the most salient information source. However, students' reliance on these sources tended to decrease from the 8th through 12th grades. Additional sources of education that seem to be underutilized are coaches, athletic trainers, and physicians. Recent reports have called for physicians to become better educated on AS use and to understand both performance benefits and potential risks associated with their use, to provide a viable, trustworthy source for the adolescent athlete (6). Educational sources for information on AS seemed to differ between self-reported users and nonusers. AS users tended to rely on multiple sources for their information, indicating that the Internet and drug dealers serve as their primary educational resource. In contrast, nonusers tended to rely on their teachers as their primary source of education on AS. These results suggest that AS users may search for the source that provides the information that he or she wants to hear, and possibly avoid figures of authority that may provide more educated, objective reasoning. This may be related to the lack of efficacy that has often been suggested by the scientific and medical community concerning AS (16). As a result, AS users may view the community of teachers and physicians as less credible sources of information.

One of the interesting aspects of this study was the examination of beliefs on AS use by adolescent males and females, and between AS users and nonusers. These questions

were based on suggestions that AS use among professional athletes tends to promote certain attitudes and beliefs among adolescents (4,20). Adolescent males and females seemed more willing to take a supplement (either a pill or powder) if it helped them achieve their fitness goals. This willingness increased as students reached the 12th grade, with 45.6% of the males in this grade indicating that they would be willing to take a supplement. This was approximately twice the rate seen among females of the same grade. More alarming was the willingness of almost 15% of the males in the 12th grade to take a substance that, although it might guarantee their fitness goals, could also harm their health, and 8.6% of these students indicated that they would continue to take the supplement even though it might shorten their life. This high-risk behavior was more common in males than in females. Furthermore, AS users were willing to take greater risks with supplement use than were nonusers. These results clearly demonstrate the increased risks that adolescent males are willing to take to achieve their athletic dreams, and how these risks are further magnified in AS users.

The influence that professional athletes have on adolescent AS use is not well known. Although it has been suggested that athletes as role models have a responsibility to their young fans (4), few studies have actually examined this influence. In this study, approximately 20% of high school age males and females suggested that professional athletes do influence their decision to use AS. However, no significant grade or gender effects were seen. When students were asked whether AS use by professional athletes influenced their friends' decisions to use AS, affirmative responses rose to nearly 50%; again, no significant grade or gender effects were noted. Interestingly, although most adolescents (> 90%) view AS use by athletes as cheating, significant grade \times gender interactions were noted, suggesting that males and females did differ on the belief that using AS by athletes is cheating, and these beliefs also differed by grade level. Similarly, grade and gender interactions were also seen in the belief that professional athletes have the right to use AS. Male adolescents tended to increase in their belief that athletes have the right to use AS, and this tendency was greater than that seen in female adolescents.

The results of this study do not provide conclusive evidence on the relationship between sport figures and adolescent drug use, but they do suggest that adolescents are influenced by media exposure of their heroes using AS. A recent study by Field and colleagues (10) indicates that participation in sports

or watching sports on television were not independently associated with using supplements, but that the combination of exposure to mass media with detailing products that improve appearance or strength may be more associated with supplement and AS use. Thus, a professional athlete or celebrity caught using an illegal supplement may contribute to such use among adolescents who are attempting to emulate them.

This study also attempted to examine whether adolescents understand the benefits and risks associated with AS use. The belief that AS can help achieve one's athletic dreams increased as students matured from the 8th to 12th grade. Concerning the legality of AS, approximately 25% of all male and female adolescents believe that it is legal to use these substances, and nearly 60% of adolescents who self-reported using AS consider them legal. This seemed to be consistent across grade and gender. Clearly, more effort is needed in educating students that AS possession is now a schedule III drug offense, punishable by fines and jail time. Regarding the health risks associated with AS, most (> 90%) adolescents state that they are aware of these dangers. Interestingly, when adolescents who self-report AS use are asked this question, approximately 60% believe that AS are dangerous. This was significantly lower than the rate seen in nonusers and, perhaps, reflects an ill-advised extrapolation of recent reports suggesting that the health risks associated with AS use in adults may be exaggerated (16).

In conclusion, this study demonstrates that reliance on nutritional supplements and ergogenic aids increases during adolescence. In addition, AS use among adolescent males and females seemed to be lower than the rates seen in other studies examining similar age groups, contrasting with a public perception that AS use is on the rise. Still, the apparent willingness of adolescent males and females to use supplements to achieve their fitness goals, even these goals may come at the expense of their health and result in shortened life spans, highlights the need for a greater involvement of schools, coaches, and physicians to provide further education on the risks and benefits of nutritional supplements and AS use. Finally, the relationship between nutritional supplements consumed and AS use in adolescents warrants further investigation concerning the influence that nutritional supplements have on potential AS use in adolescents.

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