Effects of a Multidimensional Anabolic Steroid Prevention Intervention

The Adolescents Training and Learning to Avoid Steroids (ATLAS) Program

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Objective.—To test a team-based, educational intervention designed to reduce adolescent athletes' intent to use anabolic androgenic steroids (AAS).

Design.— Randomized prospective trial.

Setting.—Thirty-one high school football teams in the Portland, Ore, area.

Participants.—Seven hundred two adolescent football players at experimental schools; 804 players at control schools.

Intervention.—Seven weekly, 50-minute class sessions were delivered by coaches and student team leaders, addressing AAS effects, sports nutrition and strength-training alternatives to AAS use, drug refusal role play, and anti-AAS media messages. Seven weight-room sessions were taught by research staff. Parents received written information and were invited to a discussion session.

Main Outcome Measures.—Questionnaires before and after intervention and at 9- or 12-month follow-up, assessing AAS use risk factors, knowledge and attitudes concerning AAS, sports nutrition and exercise knowledge and behaviors, and intentions to use AAS.

Results.—Compared with controls, experimental subjects at the long-term follow-up had increased understanding of AAS effects, greater belief in personal vulnerability to the adverse consequences of AAS, improved drug refusal skills, less belief in AAS-promoting media messages, increased belief in the team as an information source, improved perception of athletic abilities and strength-training self-efficacy, improved nutrition and exercise behaviors, and reduced intentions to use AAS. Many other beneficial program effects remained significant at the long-term follow-up.

Conclusions.—This AAS prevention program enhanced healthy behaviors, reduced factors that encourage AAS use, and lowered intent to use AAS. These changes were sustained over the period of 1 year. Team-based interventions appear to be an effective approach to improve adolescent behaviors and reduce drug use risk factors.

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ANABOLIC androgenic steroids (AAS) are used by athletes to enhance muscle growth, increase strength, and improve physical performance.[1-4] In the United States, as many as 1 million individuals are estimated to have used these drugs for athletic achievement or to gain a more muscular appearance.[5-7]

Despite the potential for enhancing athletic performance, AAS use can have adverse physical and emotional consequences[5,8-20] and has been denounced by many national and international health and athletic associations.[11-14] Reported untoward effects of AAS use include heightened coronary risk factors[16-18]; acute myocardial infarction[5,15]; cholestatic jaundice, abnormal liver function tests and hepatic tumors[8]; stunted height[1]; gynecomastia[8]; and severe mood and psychotic disorders.[19] Spread of human immunodeficiency virus (HIV) infection and viral hepatitis also is possible with needle sharing.[20]

Use of AAS has extended to adolescents. By 1990, more than 250 000 US high school students were estimated to have used AAS, with the greatest concentration among high school football players.[6,14,21] Use of AAS increased among Portland, Ore, high school football players from 1.1% in 1987[22] to 5.7% in 1991.[23,24] While regional studies have reported adolescent male AAS use greater than 10%,[25] a 1994 national survey of 12th grade males found 2.4% admitted to using AAS.[26]

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A theoretical model of AAS use and potential risk factors has been described elsewhere.[27] Use of AAS appears to be reinforced or discouraged by peers, family, coaches, media and sports figures,[28,29] and the perceived positive effects of its use (eg, increased muscular size and strength). Other possible risk factors include overestimates of AAS use among peers,[30] a "win-at-all-costs" attitude, lack of information about the adverse effects of AAS,[31] belief in personal invulnerability to unwanted effects,[32,33] impulsive and hostile behaviors, belief in media messages that promote AAS use, reduced ability to "resist" a drug offer, perceived lower personal athletic ability, poor body image, and lack of anti-AAS attitudes.[27]

Only a few preliminary studies have addressed the prevention of AAS use among adolescents,[22,27,34] and these have been limited by low numbers of participants[27] or the lack of a comprehensive approach.[22] Most previous drug abuse studies have focused on the prevention of use of tobacco, alcohol, and other psychoactive substances.[35]

We developed a school-based prevention intervention based on a theoretical model derived from AAS risk-factor research[22,23,32,34] and evaluated that program in a controlled but nonrandom feasibility trial.[27] This research showed that experimental subjects were significantly less interested in trying AAS after the intervention, and other risk factors promoting AAS use also were reduced. The results of this feasibility trial[27] and other, earlier studies[23,25,34] helped refine the theoretical model and aided in the development of hypotheses for the present investigation.

We report the first-year implementation of a multidimensional, prospective, randomized study, directed toward adolescent football players. This study compared a comprehensive school-based AAS intervention with a control condition that provided only an antisteroid informational pamphlet. The intervention, entitled the Adolescents Training and Learning to Avoid Steroids (ATLAS) program, aimed to modify behavioral intent and risk factors of AAS use, improve healthy behaviors and attitudes, and ultimately reduce actual steroid use. Based on earlier studies,[23,36] sports nutrition and effective strength training were presented as alternatives to AAS use. Because of the success of peer educators in other drug prevention programs[37] and the social influences in the team setting, a peer-taught, team-based approach was used.

METHODS

School Recruitment and Retention

Thirty-four schools in the Portland area were matched in pairs based on demographic parameters provided by the Oregon Department of Education: school size, family socioeconomic status, school attendance, student participation in free lunch program, number of students attending college, and the football team's win-loss record for the season prior to participation. Seventeen schools were randomized to the experimental condition, and 17 to the control condition.

After randomization but prior to contact with students, 3 experimental schools withdrew from the study. Reasons for declining included lack of time and local control over curricular components. Two of the unpaired control schools were matched on demographics, and 1 of these schools was randomized to the experimental condition. This resulted in the final sample of 15 experimental and 16 control schools.

Participating experimental and control schools were each provided with approximately $3000 of weight-lifting equipment prior to onset of the prevention program. This was done as a school incentive to participate and to enhance each school's exercise facility to keep students lifting weights in the school environment, since commercial gyms are a common site for acquiring AAS.[28]

Subject Recruitment and Assessment

All football players and their parents were provided a consent letter prior to football season (late summer 1994). Participants at control and experimental schools were assessed 3 times: just prior to the initial intervention session, again following the final intervention session (approximately 10 weeks apart), and a long-term follow-up assessment either at the end of the 1994-1995 school year (graduating seniors) or 1 year from the initial assessment (returning students). T-shirts or movie passes were provided for each completed assessment. Research staff administered confidential, code-numbered questionnaires in large group sessions at each school.

Questionnaire

The principal assessment instrument for both conditions at pretest was a 168-item self-report questionnaire, developed from earlier AAS investigations.[22,23,27,28] The questionnaire assessed AAS and other drug use, knowledge of drug effects, and attitudes toward and behavioral intent to use AAS. Alcohol and other drug questions were taken from national surveys.[38] Other items assessed nutrition and exercise knowledge, perceived normative drug use behaviors, belief in media messages, impulsivity, drug refusal skills, body image, feelings of athletic competence, and beliefs about parents' and coaches' AAS attitudes (Table 1). Most questions were measured using 5- or 7-point Likert agreement scales.

The self-report questionnaire used at posttest was similar to the pretest questionnaire, but omitted 14 demographic variables that were not expected to change. Experimental youth completed an additional 16 items that assessed participation in the intervention. To reduce questionnaire length, the long-term follow-up questionnaire included only 8 of the 14 demographic variables and eliminated several constructs.

Prevention Program

The program consisted of 3 components: 7 classroom sessions delivered to subjects over 7 weeks of the football season; 7 weight-room sessions delivered during the same period; and a single parent evening session.

Classroom.—The 7 classroom sessions were led by the coaching staff and peer educators. Approximately 60% of the curriculum was directed by peers[37] in small groups. Sessions were observed by research staff to assess coach and peer-leader fidelity to the curriculum.

The curriculum addressed the risk factors of AAS use, strength training, and sports nutrition. Skills to refuse offers of AAS and other illicit drugs were practiced.[39] Each peer-led group developed and presented anti-AAS media messages.

A pocket-sized sports nutrition guide and a weight-training booklet (Table 2) were distributed to all experimental students. Nutrition recommendations for a high-protein, low-fat diet were presented, with suggested meals for school, home, and fast-food restaurants. Vitamins, minerals, and unsubstantiated athletic ability-enhancing claims of various over-the-counter supplements were discussed. The weight-training booklet demonstrated established strength-conditioning techniques.

Body-building magazines were reviewed. Students critiqued the claims of supplement advertisements, recognized AAS adverse effects in pictured athletes, and identified advertised treatments for AAS adverse effects (eg, hair replacement, breast reduction surgery, acne treatment).

Weight Room.—Seven weekly weight-training sessions were presented to experimental subjects at school gyms by ATLAS staff trainers. These sessions provided demonstrations of different weight-lifting techniques. This contact time also was used to reinforce other elements of the classroom curriculum.

Table 1.—Pretest Internal Reliability of Constructs Measured in Questionnaire (Including Sample Items)*

Construct and Sample Items	Cronbach α
Intent to use AAS (5 items) I am curious to try anabolic steroids.	.920
Intent to use AAS for specific rewards (3 items) I would use anabolic steroids if they would help me get a college athletic scholarship.	.873
Nutrition behaviors (7 items) I keep track of the calories I eat.	.822
Number of meals eaten per week (3 items) How many times per week do you generally eat breakfast?	.618
Strength training self-efficacy (6 items) I know how to train with weights to get as strong and as quick as possible.	.860
Perception of athletic competence (4 items) My athletic ability will continue to improve if I work on it.	.853
Ability to turn down drugs (4 items) I would be comfortable turning down a weight lifter who offered me anabolic steroids.	.880
Belief in media advertisements (3 items) I think that most products advertised in muscle magazines do what they claim to do.	.746
Team as an information source (3 items) Being on the football team teaches players about getting stronger.	.750
Peers as an information source (3 items) My team leaders help me learn about sports nutrition.	.845
Coach as an information source (3 items) My coaches help me learn about drug use in sports.	.746
Knowledge of effects of AAS (18 items) I believe that anabolic steroids can cause liver disease.	.861
Knowledge of effects of alcohol (3 items) Alcohol can cause muscles to become weaker.	.326
Knowledge of supplements and exercise (4 items) Protein powders are better for you than protein in food.	.433
Perceived coach tolerance of AAS use (3 items) If I were caught using anabolic steroids, I would be in trouble with my coaches.	.593
Perceived parent tolerance of AAS use (3 items) At my house, there are rules against using anabolic steroids.	.559
Perceived peer tolerance of drug use (5 items) My teammates wouldn't care if I used marijuana.	.915
Perceived friend tolerance of drug use (5 items) My closest friends wouldn't care if I used alcohol.	.886
Normative beliefs about AAS use (3 items) Out of every 100 high school football players at your school, how many do you think have ever used anabolic steroids, even once?	.814
Communication with peers (3 items) If you had a problem or question about steroids, how easy would it be to talk to your friends about it?	.766
Self-esteem (4 items) I feel that I have a number of good qualities.	.873
Impulsivity (6 items) I can't control myself when I get angry.	.811
Body image (3 items) I have been happy with the changes in my body over the last few years.	.826
Perceived severity of AAS use (3 items) Anabolic steroids are not dangerous if you use them only a few months each year.	.830
Attitude toward AAS users (3 items) I think people who use anabolic steroids are cheaters.	.596
Perceived vulnerability to AAS effects (3 items) If I were to use anabolic steroids, I wouldn't have any bad side effects.	.722
Attitudes toward AAS use (3 items) Using anabolic steroids is like using any other illegal drug.	.401
Win-at-all-costs attitude (3 items) When I play football, I want to win, no matter what it takes.	.682
Friend drug use (4 items) How many of your 5 closest friends have ever used or tried cigarettes, even once?	.770

*Reliabilities are the unstandardized coefficients. This table includes only those subjects who completed both the pretests and posttests. AAS indicates anabolic androgenic steroids.

Table 2.—Contents of Pocket-Sized Sports Nutrition Guide and a Weight-Training Booklet Distributed to All Experimental Students

Sports Nutrition Guide
1. Nutrient definitions and function
2. Calculating each individual's protein and energy requirements
3. Fluid requirements
4. Reading food labels
5. Fast-food section (preferred choices)
6. Common food chart listing energy, fat, protein
7. Vitamins and supplements descriptions
8. Goal work sheets

Weight-Training Guide
1. Weight-training phases
2. Weight-training term definitions
3. Changes resulting from weight training
4. Types of weight training
5. Plyometrics, speed, safety
6. Exercise charts and pictures

Implementor Training.—Coaches in the experimental condition were given a day-long in-service and a curriculum guide with specific lesson plans. Peer leaders, selected by coaches, were trained by research staff over a 4- to 6-hour period. They were provided with curriculum manuals and step-by-step lesson plans and activities to use in the classroom.

Parent/Guardian.—Parents and guardians of experimental student-athletes were provided a family sports nutrition booklet. This guide was similar to the student's nutrition guide but also included a description of the ATLAS program, food shopping advice, and sports nutrition menus. Parents of experimental subjects were invited to a single evening meeting, delivered by ATLAS staff. The session centered on program goals, a description of the intervention, and a question-and-answer session.

Control Condition

All control students were given a standard, commercially produced pamphlet,[10] listing the problems associated with AAS use and the ethics of fair play and sportsmanship. No other steroid prevention materials were provided, and students did not receive other team-directed drug education.

Data Analysis Plan

The program effects were estimated separately with the conditional regression model at the postintervention (short-term) assessment and at the long-term follow-up. The posttest assessments served as the dependent variables, and the pretest (baseline) assessment and program exposure were independent variables. The program effect estimate was the difference between experimental and control subjects at posttest adjusted for the pretest levels for each subject. The analyses also were conducted at the school-level of analysis because of the randomization scheme and because of the possibility of spurious results when analyzed only at the individual subject level.[11] Although we present significance levels for both school-level and individual subject–level analyses in tabular form, in the narrative we describe individual-level analysis effects, as they did not differ considerably from the school-level analysis for most constructs and because the program is directed at the individual. Program effects also were estimated after adjustment for age, student grade point average, and father's education, due to baseline differences on these demographics. School-level analysis results and demographic-adjusted effects are highlighted when they provide additional information.

The long-term follow-up data for graduating seniors was combined with long-term follow-up assessment for returning players. Together, these data comprise the long-term follow-up. In the analysis of long-term effects, a variable coding for whether the respondent was a graduating senior or not was included as a covariate. The proportion of graduating seniors was a covariate in the school-level analysis.

Individual questionnaire items were combined into summary scales representing constructs from a model of AAS use, as is common in health research.[12] Table 1 presents the constructs and the generally positive psychometric properties of the subscales; these findings are consistent with results obtained from an earlier version of this instrument.[27] Sum scores were divided by the number of items in each construct; most constructs were measured by a minimum of 3 items. These mean scores are represented as the pretest for the control and intervention groups. To aid in interpretation of the program results and provide an indication of variance, the postintervention (immediate) and long-term follow-up changes are expressed as percent change in pretest SD units (positive or negative) for each variable. The SD in the table was derived from the pretest-posttest intervention sample for both experimental and control subjects. Also, cumulative lifetime AAS use at each follow-up is presented.

Table 3.—Individual-Level Comparison of Demographic Characteristics Between Experimental and Control Subjects Present at Both Pretest and Posttest (N=1226)

Demographics	Control (n=694)	Experimental (n=532)
Age, mean (SD), y*	15.78 (1.16)	15.93 (1.10)
Grade point average, mean (SD)†‡	3.12 (0.62)	3.01 (0.60)
Attend religious services weekly, %	26.8	29.8
Race/ethnicity, %		
Asian	3.5	3.8
Native American	0.3	0.9
Hispanic	3.1	2.8
African American	3.9	6.6
White	81.1	76.7
Mixed heritage	8.1	9.1
Father graduated from college, %†	56.1	47.5
Father unemployed, %	3.0	2.6
Mother graduated from college, %	43.8	39.9
Mother unemployed, %	17.5	16.2
Family income $40 000, %*	71.0	62.4
Live with mother or adult female guardian, %	91.5	91.0
Live with father or adult male guardian, %	80.5	81.4
Parents are divorced, %	29.8	32.2

*P .05.
†P .01.
‡Based on a 4.00 scale.

RESULTS

Demographics

Table 3 presents selected demographics for subjects completing both pretest and posttest assessments, by condition. Altogether, 26 comparisons were made; thus, 1 group difference would be expected by chance. Continuous variables were examined with t tests and categorical variables were examined with χ^2 tests. All participants were male. Control subjects were slightly younger (mean difference of approximately 7 weeks; P=.02), had a slightly higher mean grade point average (3.12 vs 3.02 [on a 4.00 scale] for experimental subjects; P=.003), had fathers who were slightly more educated (P=.004), and had higher family incomes (P=.01).

Subject Retention

Because football team size generally shrinks during the first few weeks of school (due to dropouts), precise estimates of the potential subject pool are not available. Approximately 15% to 20% fail to complete the football season. A total sample of 1506 youth completed the pretest questionnaire (702 in the experimental schools [an average of 46.8 per team] and 804 in the control schools [an average of 50.3 per team]). Of this initial sample, 1226 (81.4%) completed the posttest assessment (532 in experimental and 694 in control schools). A total of 869 youth (57.7%) completed the third, long-term follow-up assessment (407 in experimental and 462 in control schools). Altogether, 88.2% of all enrolled youth completed the baseline assessment and at least 1 of the 2 remaining follow-up assessments. Fewer subjects were retained in the experimental condition (75.8%) than the control condition (86.3%) from baseline to immediately postintervention (z=5.23, P<.001). This was expected, as the participation burden was much greater for adolescents attending the 14 intervention sessions. However, there was no significant difference in subject retention in the control vs the experimental conditions at the long-term follow-up assessment (z=0.14, P=.44). From short-term to long-term follow-up, there was 70.8% subject retention, similar to mean student retention in Portland public schools (71.6%) from year to year.

Baseline Equivalence

Baseline equivalence for individual constructs targeted by the ATLAS intervention (α levels) are 2-tailed. Individual-level analyses indicated that experimental and control subject significantly differed on several variables prior to the intervention (Table 4). Students in the experimental schools had poorer nutrition behaviors (P=.02), had lower strength-training self-efficacy (P<.001), perceived themselves as more athletically competent (P=.006), were less likely to believe in media advertisements (P=.04), were less likely to view their peers as a good information source (P=.03), had greater knowledge of nutritional supplements/exercise (P=.01), and believed their coaches were less tolerant of AAS use (P=.03).

Preintervention differences between experimental and control groups may be more likely to occur when schools are randomly assigned to conditions and data are analyzed at the individual level, as in this study. When these dependent variables are examined at the school level for baseline equivalence, only 1 preintervention difference (perception of athletic competence) remains. When principal outcome questions were reanalyzed accounting for several variables that differed at baseline, the findings were essentially unchanged.

Program Effects

The analysis includes all 31 participating schools, and program effects are adjusted for pretest scores. Table 4 lists the program effect for each of the constructs and the level of significance. Baseline (pretest) means for control and intervention participants are shown. Although levels of significance were assessed by analysis of mean scores, to aid in the presentation, the degree of change in postintervention and long-term follow-up is displayed as a percent change in SD units. The baseline SD represents the pretest-posttest SD for all participating schools. Each SD unit was then derived by calculating the change in the mean, divided by the baseline SD at each follow-up.

Table 4.—Short- and Long-term Program Effects, Analyzed at Individual Subject and School Levels*

Variables	SD‡	Control Group			Experimental Group			Significance (*P* Values)			
		Mean Score Pretest§	% Change in SD Units†		Mean Score Pretest§	% Change in SD Units†		Pre-Post (Short-term) Program Effects		Pre-Follow-up (Long-term) Program Effects	
			Posttest	Follow-up		Posttest	Follow-up	School Level	Subject Level	School Level	Subject Level
Intent to use AAS	1.24	1.74	4.8	5.7	1.65	−3.2	2.4	.02|	.009	.02|	.02
Intent to use AAS for specific reward	1.60	2.41	10.6	NA	2.33	5.6	NA	.19	.04	NA	NA
Nutrition behaviors	1.15	4.04	1.7	0.9	3.88	42.6	20.9	<.001	<.001	.05|	.03
Number of meals per week	1.21	6.16	7.4	−9.8	6.02	7.4	9.8	.18	.13	.49	.50
Use of school instead of private gym	2.47	1.74	9.7	−10.4	1.79	21.9	14.5	.02	<.001	.04	.001
Strength training self-efficacy	1.08	5.89	13.9	−2.7	5.62	40.7	36.4	<.001	<.001	<.001	.004
Perception of athletic competence	0.86	6.10	9.3	7.0	6.25	9.3	−3.5	.02	<.001	.17	.03
Ability to turn down drugs	1.35	6.00	−10.4	9.7	6.06	9.6	0.0	<.001	<.001	.02|	.03
Belief in media advertisements	1.24	2.80	4.8	2.4	2.65	−37.9	30.2	<.001	<.001	.004	<.001
Team as an information source	1.10	5.58	14.6	2.7	5.59	38.2	23.6	<.001	<.001	.01	.001
Peers as an information source	1.55	4.56	8.4	3.9	4.36	68.4	51.6	<.001	<.001	<.001	<.001
Coach as an information source	1.27	5.37	12.6	NA	5.27	37.8	NA	<.001	<.001	NA	NA
Knowledge of effects of AAS	4.42	10.24	10.9	5.0	10.64	40.3	41.5	<.001	<.001	<.001	<.001
Knowledge of effects of alcohol	0.78	1.85	2.6	1.3	1.84	24.4	15.4	.003	<.001	.02	.003
Knowlege of supplements/exercise	1.16	1.89	9.5	9.2	2.07	70.7	46.7	<.001	<.001	<.001	<.001
Perceived coach tolerance of AAS use	1.20	2.15	10.0	11.1	2.00	13.3	0.9	.008	<.001	.16	.05|
Perceived parent tolerance of AAS use	1.37	2.62	8.0	NA	2.58	2.2	NA	.11	.02	NA	NA
Perceived peer tolerance of drug use	1.82	3.04	8.2	29.1	3.15	5.5	22.4	.07	.048	.36	.50
Perceived friend tolerance of drug use	1.82	3.27	3.3	NA	3.21	−2.2	NA	.18	.08	NA	NA
Normative beliefs about AAS use	1.56	2.39	10.3	6.5	2.36	18.6	11.8	.03	.06	.30	.43
Communication with peers	0.74	3.24	2.7	NA	3.26	12.2	NA	.25	.03	NA	NA
Self-esteem	1.07	5.94	15.0	2.9	6.05	3.7	2.9	.01	<.001	.02||	.04||
Impulsivity	1.28	2.96	4.7	6.4	2.94	10.2	0.8	.003	<.001	.31	.21
Body image	0.86	3.81	8.1	NA	3.80	10.5	NA	.48	.36	NA	NA
Perceived severity of AAS use	1.27	5.79	11.8	16.5	5.86	23.6	4.7	<.001	<.001	.03	<.001
Attitudes toward AAS users	1.40	4.86	2.1	2.2	4.87	12.9	5.8	.009	.01	.34	.43
Perceived vulnerability to AAS effects	2.10	6.05	4.8	4.8	6.11	17.6	8.6	.003	<.001	.02||	.009
Attitudes toward AAS use	1.41	5.16	7.1	2.9	5.25	9.9	8.6	.10	.09	.13	.06
Win-at-all-costs attitude	1.44	4.16	1.4	NA	4.09	4.9	NA	.12	.25	NA	NA
Friend drug use	1.35	2.09	5.2	NA	2.21	3.1	NA	.08	.07	NA	NA
Cumulative lifetime AAS use¶	...	2.4%	3.4%	3.9%	1.4%	1.9%	2.3%	.36	.17	.34	.20

*AAS indicates androgenic anabolic steroids; and NA, construct not assessed at long-term follow-up.
†Percent change in pretest SD units, based on the sample of participants at pretest, posttest, and follow-up.
‡SD for the pretest-posttest sample, both control and experimental groups combined.
§Mean questionnaire item scores.
|Adjusted for baseline grade point average, age, and father's education.
¶Lifetime use determined by pretest use and new reported use at posttest and follow-up.

Significant individual-level program effects were observed in many areas. All program effect α levels presented in the narrative are for individual-level analyses and represent pretest to posttest intervention change, unless otherwise noted. We report 1-tailed tests of significance for all analyses, basing outcome predictions on the findings of our previous investigations with similar design and intervention.[21,27] The magnitude of the program effect was estimated with the partial correlation coefficient, which is the correlation between the dependent variable and program exposure, adjusted for other independent variables. Partial correlations for significant effects ranged from 0.05 to 0.41 for the smallest and largest program effects, respectively.

Behavioral Intent

When analyzed at the individual level, athletes in the experimental group had less short-term (P=.009) and long-term (P=.02) intent to use AAS than did control students. When analyzed at the school level, there was a nonsignificant short- and long-term trend in the predicted direction, both of which became significant at the $P<.05$ level when adjusted for baseline differences in grade point average, age, and father's education. Intent to use AAS for specific rewards (eg, athletic scholarship or professional contract) was significantly different for the individual level (P=.04) but not the school-level analysis at the short-term assessment point. This latter construct was not assessed at the long-term follow-up.

Behaviors

Compared with controls, students in the intervention group reported improved sports nutrition behaviors ($P<.001$) and greater use of school rather than private gyms ($P<.001$) from before to after the intervention. Greater experimental subject use of school rather than private gyms and improved nutrition behaviors persisted through the long-term follow-up ($P<.001$ and P=.03, respectively). Eleven participants reported new lifetime AAS use over the initial 10-week interval, with more than twice as many new users (n=8) from the control group as from the experimental condition (n=3). At the long-term follow-up, there were 4 additional new lifetime AAS users in the control group and 3 new users in the experimen-

tal condition. However, total AAS users (current and past use) did not achieve a significant difference ($P=.08$ at long-term follow-up) between conditions at any time.

Knowledge

Compared with control subjects after the intervention, experimental adolescents demonstrated greater knowledge of the consequences of AAS ($P<.001$) and alcohol use ($P<.001$) and improved knowledge about supplements and exercise ($P<.001$). At the long-term follow-up, experimental subjects continued to report greater knowledge of effects of AAS ($P<.001$) and alcohol ($P=.003$) and greater knowledge about supplements and exercise ($P<.001$).

Nonpeer Influences

Compared with control students, athletes in the experimental condition believed their coaches ($P<.001$) and parents ($P=.02$) were less tolerant of AAS use and were more likely to believe their coach was a reliable information source about drugs ($P<.001$). Athletes in the experimental group were more skeptical of advertisements for muscle-building products ($P<.001$). Relative to controls, experimental subjects remained skeptical of media influences promoting the image of AAS use ($P<.001$) at long-term follow-up.

Peer Influences

Athletes in the experimental group had greater belief in their team and peers as trusted information sources both at short-term (both $P<.001$) and at long-term follow-up ($P<.001$ for peers and $P=.001$ for team). Normative beliefs about AAS use improved at short-term follow-up ($P=.03$) at the school level, but this effect did not persist at long-term follow-up ($P=.30$). Although no school-level differences were observed in perceived friend or peer tolerance of drug use, individual-level analyses indicated significantly lower perceived peer tolerance of drug use reported by experimental subjects ($P=.05$) at the short-term assessment. No program effects were obtained for friend drug use at either short-term or long-term follow-up.

Individual Factors

Students in the experimental group had greater short-term ($P<.001$) and long-term ($P=.03$) feelings of athletic competence, short-term ($P<.001$) and long-term ($P=.004$) confidence in their ability to strength train (self-efficacy), short-term ($P<.001$) and long-term ($P=.03$) ability to refuse AAS and other drugs, short-term ($P<.001$) and long-term ($P=.04$) increase in self-esteem, and short-term improved communication with peers ($P=.03$). Also, experimental students reported less impulsivity ($P<.001$) at the short-term follow-up. Body image was not significantly different between experimental and control groups at short-term follow-up.

Attitudes

After the intervention, experimental students were more likely to believe in the potential severity of AAS use risks ($P<.001$), had more unfavorable attitudes toward AAS users ($P=.01$), and felt more personal vulnerability to the negative effects of AAS use ($P<.001$). No difference in the win-at-all-costs attitude was found among groups from before to after the intervention. At the long-term follow-up, experimental subjects continued to be more likely to perceive AAS adverse effects as severe ($P<.001$) and saw themselves as remaining more vulnerable to adverse AAS effects ($P=.009$), relative to controls.

COMMENT

This study proved successful in demonstrating distinct advantages for the experimental condition. The intervention was associated with significant reductions in adolescent intent to use AAS, greater knowledge of AAS and other drug effects, greater belief in personal vulnerability to the harmful effects of AAS use, more negative attitudes about AAS users, reduced impulsivity, improved feeling of athletic abilities, higher self-esteem, stronger belief that coaches and parents were against AAS use, more competent drug refusal skills, less belief in media messages, increased belief in the football team as an information source, increased knowledge of advertised "ergogenic" supplements, and improved nutrition and exercise behaviors. The partial correlation coefficients for significant program effects ranged from 0.05 to 0.41, which represents substantial effects for prevention research. Students receiving the intervention were more likely to increase their strength-training practice in the school environment, despite similar equipment improvements in control and experimental weight rooms. This is important since local gyms are the greatest reported source for acquiring AAS in the United States.[28] Importantly, many of these favorable changes, including a reduced intent to use AAS, persisted at the long-term follow-up, despite students being away from the football team setting. The consistency between the school- and individual-level analyses and the results of the pilot program[27] promotes confidence in the effectiveness of this program.

Because the intervention was designed to change AAS risk factors rather than decrease immediate use, prevention of new AAS use among study subjects was not expected to reach significance over this relatively limited initial follow-up period. Despite this, more student-athletes in the control condition reported new lifetime AAS use compared with the experimental group (12 vs 6 new cases, respectively), by the long-term follow-up. Most new use occurred during the football season (8 in control schools and 3 in intervention schools). If this trend continues through the remaining 3 years of this investigation, a significant reduction of future AAS use by adolescents will be achieved.

Of the 31 variables assessed at short-term follow-up, more than 77% (24 of 31) were found to significantly improve at either or both the school and individual level of analyses. Although many positive program effects were found in this initial period, it is not unusual in drug prevention research for early positive findings to diminish over time.[13] While most improvements persisted, a reduction in long-term program effects was found for some potential AAS risk factors. To revive the initial positive effects of this program over the remaining years of follow-up, annual "booster sessions"[11] will be conducted to reactivate experimental adolescents' use of the sports nutrition, drug prevention, drug refusal, and strength-training skills taught in the initial intervention. However, these beneficial long-term program effects were detected before any booster sessions had been conducted, strengthening the argument that the original intervention had broad and persistent effects.

The results from many substance abuse programs for adolescents, including anabolic steroid interventions, often report what does not work rather than what is successful.[11,15,16] Unique features of the ATLAS intervention may explain the favorable outcomes. Many adolescent drug prevention programs are presented in a health class setting, with loose peer relationships and a teacher who has only modest contact time with students. In contrast, the ATLAS intervention takes place in the atmosphere of an athletic team setting with peers who share common goals. The coaches have significant contact time and investment with students and can exert considerable influence. Parents are involved through parent meetings and distributed copies of the AAS information and sports nutrition booklets. Peer leaders also teach a major portion of the intervention. These differences may account for some of the favorable findings. Future research should examine the relative contribution of these factors, by systematically comparing AAS prevention interventions with and without these components.

The dietary habits and nutritional knowledge of adolescents are generally considered poor.[47] While many adolescents do not intend to use AAS, those with gaps in healthy nutrition benefited from the health promotion curriculum. Using an athlete's motivation to enhance performance may capitalize on a teachable moment to go beyond preventing unwanted outcomes (eg, AAS use) to establishing health-promoting behaviors. Subsequent longitudinal follow-up will define the durability of these changes.

Somewhat unexpectedly, the significant short-term program effects for AAS mediating factors such as self-esteem and impulsivity were of greater magnitude at the initial postintervention assessment than observed program effects on intent to use AAS. A likely reason for this pattern of findings is the "basement effect": baseline levels of intent to use AAS were relatively low in both control and experimental groups, leaving little room for improvement and thus making it difficult to find certain program effects of substantial magnitude. Although the content of the ATLAS intervention did not directly attempt to impact self-esteem or impulsivity, these factors may have improved among experimental youth as they were successful in learning new anti-AAS and health behavior skills. Effects on these potential mediators were less pronounced at the long-term follow-up, suggesting that changes on these measures may be transitory. There also may be specific aspects of the football season that promote undesirable changes in these factors, which the intervention counteracted. This was particularly evident for impulsivity, which worsened during the football season in the absence of the intervention (ie, in the control condition), and then rebounded at the long-term follow-up.

There are limitations to the investigation. As is true for the majority of psychosocial intervention studies, subject dropout was noted at short- and long-term follow-up across both conditions. However, this rate may have been artificially inflated because participation in the study in both conditions was contingent on remaining on the football team. Overall, approximately 15% to 20% of the preseason football squad at each school quit or was eliminated from the team by the season's end. This likely contributed to dropout in adolescent participation. The retention rate in the schools also had an impact on long-term follow-up. A mean of only 71.6% of students return to the same school from year to year in the Portland public high schools. Our long-term retention of 70.8% between the short- and long-term assessment mirrors this measure. The lack of full retention was not likely based on study factors, but on sport team and school population stability.

Older male participants in recent national surveys[26] (presumed to be more likely to be using AAS) reported only 2.4% AAS use. This is similar to the lifetime reports of AAS use in the control (2.4%) and experimental (1.4%) samples at baseline. However, higher rates of AAS use by adolescent males have been reported—as high as 6.6% and 11% in completely anonymous, 1-time surveys[6,21,25] among older high school students. The cumulative AAS lifetime use rates at long-term follow-up were increased to 2.3% in experimental subjects and 3.9% in controls. Initial rates of AAS, amphetamine, and marijuana use were similar among our subjects and 11th-grade high school males in Oregon.[18] These findings indicate that the respondents were forthcoming about drug use and make it less likely that significant underreporting about any drugs occurred, including anabolic steroid use.

A differential dropout rate was observed at the first postintervention assessment, with a smaller proportion of the experimental group completing the short-term follow-up questionnaire. However, differential dropout was not observed at long-term follow-up. Greater short-term experimental dropout may have been a function of the greater participation burden on the these subjects, who were required to attend the 14 intervention sessions as well as complete the questionnaires. Examination of this dropout rate suggests that program effects would have been even larger if equal proportions of control and experimental students had been retained. Dropouts from the control group had significantly higher baseline intentions to use AAS than dropouts from the experimental group. If these subjects had been retained, the postintervention contrast between the 2 conditions would have favored the experimental intervention even more.

Baseline comparisons of groups on dependent and demographic variables revealed several differences. Experimental youth reported less desirable baseline levels of several hypothesized risk factors for AAS use (eg, poorer dietary behaviors, poorer strength training self-efficacy) although they had a lower initial intent to use AAS. Given these baseline differences between conditions, the "regression to the mean" artifact could have contributed to the observed result that experimental subjects significantly improved on these factors from before to after the intervention. However, a number of the program effects were observed across multiple assessments over time, and means for the 2 conditions on these variables were observed to diverge over time, reducing the plausibility of this interpretation. In addition, subsequent analyses that do not assume regression to the mean demonstrated that (with few exceptions) no substantial change in the results were detected when controlling for these baseline differences.

Another potential problem was the preintervention dropout of 3 schools, necessitating the rerandomization of 1 control school to the experimental condition before assessment or intervention took place. Although the reassigned school was matched on demographics with 1 of the remaining control schools, this technically altered the initial randomization outcome for 1 school. Nonetheless, we are confident that this limited reassignment of 1 school did not significantly bias the positive preventive outcomes.

Voluntary (consented) student involvement in the program could result in findings that are limited to male football players already motivated to accept an anti-AAS program. Similarly, consenting parents/guardians may have been more involved with their children, and thus may not be representative of all parents. Caution should be used in generalizing these findings to unselected (eg, not consented) sports teams or to other adolescent populations.

In summary, this multidimensional, team-based prevention program successfully altered many AAS use risk factors and improved the practice of healthy alternatives to AAS use. As expected, program benefits were greatest at the end of the football season. While some effects diminished over time, the majority were sustained. However, these positive short-term effects were timed to influence student-athletes at the period of greatest AAS risk: during active football season. Reduced intentions to use AAS, favorable changes in risk factors, and beneficial behavior change continued to be associated with the intervention at the long-term follow-up (up to 1 year after the baseline assessment). The ATLAS intervention will continue for 3 more years, expanding the sample size with additional participants each year. Annual booster sessions will be conducted to maintain gains and address any risk factors that were not significantly altered during the initial intervention year.

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