ELSEVIER

Journal of Adolescent Health 41 (2007) 421–429

JOURNAL OF ADOLESCENT HEALTH

Original article

Outcomes of a Prospective Trial of Student-Athlete Drug Testing: The Student Athlete Testing Using Random Notification (SATURN) Study

Linn Goldberg, M.D.[a,*], Diane L. Elliot, M.D.[a], David P. MacKinnon, Ph.D.[b], Esther L. Moe, Ph.D.[a], Kerry S. Kuehl, M.D., Dr.P.H.[a], Myeongsun Yoon, M.A.[b], Aaron Taylor, M.A.[b], and Jason Williams, M.A.[b]

[a]*Department of Medicine, Oregon Health & Science University, Portland Oregon*
[b]*Department of Psychology, Arizona State University, Tempe, Arizona*

Manuscript received May 28, 2007; manuscript accepted July 20, 2007

See Editorial p. 419

Abstract

Purpose: To assess the effects of random drug and alcohol testing (DAT) among high school athletes.
Methods: This was a 2-year prospective randomized controlled study of a single cohort among five intervention high schools with a DAT policy and six schools with a deferred policy, serially assessed by voluntary, confidential questionnaires. DAT school athletes were at risk for random testing during the full academic year. Positive test results were reported to parents or guardians, with mandatory counseling. Indices of illicit drug use, with and without alcohol use, were assessed at the beginning and end of each school year for the past month and prior year. Potential mediating variables were evaluated.
Results: Student-athletes from intervention and control schools did not differ in past 1-month use of illicit drug or a combination of drug and alcohol use at any of the four follow-up periods. At the end of the initial school year and after 2 full school years, student-athletes at DAT schools reported less drug use during the past year ($p < .01$) compared to athletes at the deferred policy schools. Combining past year drug and alcohol use together, student-athletes at DAT schools reported less use at the second and third follow-up assessments ($p < .05$). Paradoxically, DAT athletes across all assessments reported less athletic competence ($p < .001$), less belief authorities were opposed to drug use ($p < .01$), and indicated greater risk-taking ($p < .05$). At the final assessment, DAT athletes believed less in testing benefits ($p < .05$) and less that testing was a reason not to use drugs ($p < .01$).
Conclusions: No DAT deterrent effects were evident for past month use during any of four follow-up periods. Prior-year drug use was reduced in two of four follow-up self-reports, and a combination of drug and alcohol use was reduced at two assessments as well. Overall, drug testing was accompanied by an increase in some risk factors for future substance use. More research is needed before DAT is considered an effective deterrent for school-based athletes.

Keywords: Adolescent; Drug and alcohol testing; High school; Substance use

More than 50% of high school students in the United States are involved in school-sponsored sports [1]. Unfortunately, participating in school athletics does not protect from harmful behaviors, and adolescent athletes use drugs and alcohol at rates similar to those for other students [2–6]. Drug and alcohol testing (DAT) has been considered as a way to prevent, identify, and treat substance use [7–12]. In 1995, the United States Supreme Court affirmed the legality of random drug testing among adolescent athletes engaged in school-sponsored sports [13], and in 2002 a school's right to drug test was extended to students involved in all extra-

*Address correspondence to: Linn Goldberg, M.D., Professor of Medicine, Oregon Health & Science University, 3181 SW Sam Jackson Park Road (CR 110), Portland, OR 97239-3098.
E-mail address: goldberl@ohsu.edu

1054-139X/07/$ – see front matter
doi:10.1016/j.jadohealth.2007.08.001

curricular school-based activities [14]. High schools have been encouraged to implement drug and alcohol testing (DAT) programs [8], and federal grant support is available for those endeavors [9].

To date, there is little research and no randomized trials to establish whether student-athlete DAT is an effective deterrent. Some anecdotal reports suggest that drug testing may retard drug use [10,15,16], and a small nonrandomized study of two rural schools suggested that drug testing can reduce past 30-day substance use [17]. However, a large epidemiologic analysis of schools with various drug testing policies failed to find any prevention effect [7], and others have theorized that drug testing in high school would have adverse effects [18]. We report the findings from the first prospective randomized control trial, the Student Athlete Testing Using Random Notification (SATURN), to assess the deterrent effects and impact of potential mediators of drug and alcohol testing among students engaged in high school sports.

Methods

School recruitment

School recruitment began by disseminating study information to public high schools within 150 miles of Portland, Oregon. Researchers contacted schools directly, and some schools contacted the Oregon Health & Science University after media announcements about the study. For those interested, informational meetings were held with school officials, parents, students and school boards. Criteria for school participation included no prior student-athlete drug testing program, agreeing to implement a program meeting Supreme Court specifications, and cooperation of the school administration, school board, parent groups, and students. All enrolled schools agreed to develop mandatory student-athlete DAT programs in which sport participants would be at risk for drug testing during the entire school year, using legal policy templates [13,19,20]. After randomization, schools would either implement their policy or defer implementation until study completion. The schools' DAT programs were funded by the study, and all schools received compensation for protocol administrative expenses.

Each participating school developed their unique DAT policy, based on the U.S. Supreme Court decision [13] and modeled after the Oregon School Board's Association Selected Sample Policy [19]. Drug test results were confidential, with findings known only to the designated school administrator, the student, and the student's parent(s) or legal guardian(s). In part because school sports are extracurricular, DAT policies for positive tests were academically nonpunitive, without legal or school sanctions, and not entered into the student's permanent record [13,19]. Students testing positive for any drug or alcohol were to be referred for mandatory counseling after parent or guardian notification. If the student refused counseling after a positive test, the student would be barred from sports participation, as per school policy. This study was approved by the Institutional Review Board of the Oregon Health & Science University.

School enrollment and randomization

Eighteen recruited Oregon high schools from 14 districts agreed to participate and were matched in dyads according to athletic division (4A, 3A, 2A, A), corresponding to the total number of students in each school. Schools were randomly assigned to implement their testing policy or the control condition (deferred testing) by statisticians at Arizona State University (Figure 1). Before completion of baseline assessments, five schools (two intervention, three control) from a single district were eliminated because of study protocol infringements. After drug testing was initiated, two schools changed from a full academic year testing policy to a season-only testing after a court challenged one of the district's schools [21], necessitating their elimination from this assessment. Thus, five intervention schools and six deferred DAT control schools completed the 2-year study.

Athlete participants

During the fall at all study schools, students declared their intent to participate in sport participation during the school year, and athletes and their parent(s) or guardian(s) completed consent forms for school-sponsored sport participation. At DAT policy schools, that included consenting to each school's testing policy. Participating in school athletics was not contingent on signing the consent to complete study surveys. Student-athletes at both DAT and deferred (control) condition schools also were asked to participate in study surveys with an informed consent for student-athlete and parental/guardians for these questionnaires.

Only the inception cohort of student athletes is used in data analysis. Because athletes, at their discretion, could take the confidential survey during each follow-up period, the numbers of students varied during each assessment. Only students who were initially freshman or sophomores were anticipated to be available for the final survey administration, during school year 03 of the study.

Drug testing procedures

Testing schedules were designed to assess approximately half the total number of student-athletes per school, with an approximate biweekly testing schedule. Fifteen random visits per school throughout the academic year were schedule for DAT with more students selected per visit at larger schools. The time and day of the week testing varied randomly. All athletes were eligible for each visit's draw, with selection by random numbers generated using a computer program based at Arizona State University. Athletes' names

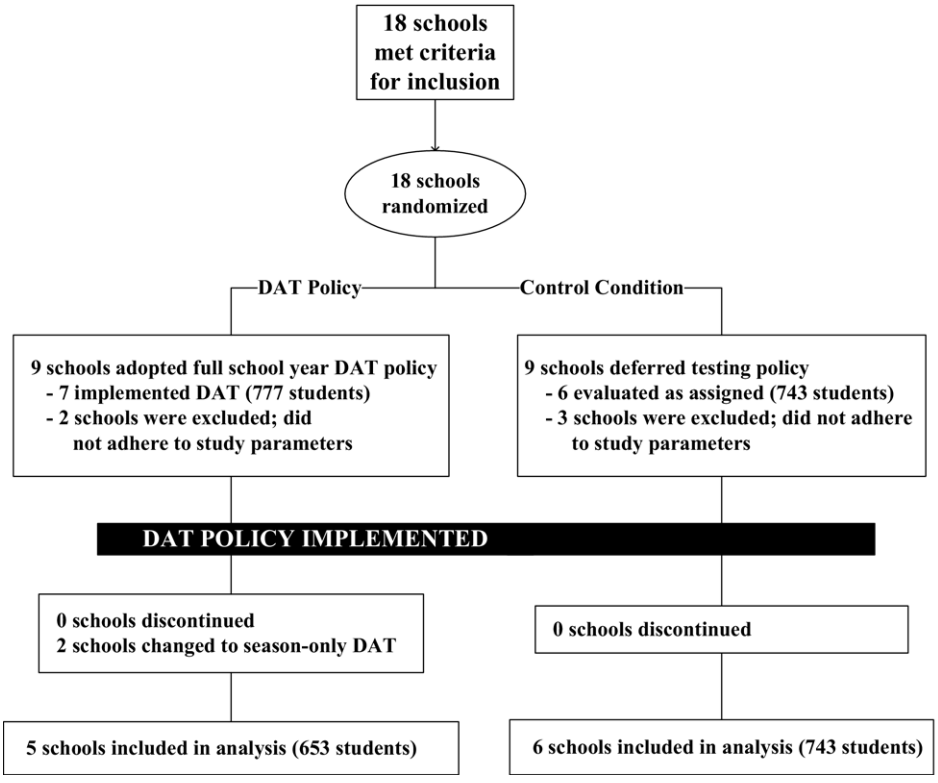

Figure 1. School Enrollment, Randomization and Retention.

were communicated to school personnel when study staff arrived at the school, only after opening a sealed envelope. School staff notified the student and accompanied him or her to the testing area. Specimen collection procedures were explained by study staff. Sealed commercial bottled water was available to student-athletes. If any students were absent, preselected replacement students were identified by a random number backup list. The "absent" student was tested at the next random test, without knowledge of his or her prior selection. Although individual student privacy was maintained during testing, bathrooms were restricted and signs were placed to make students aware that drug testing was occurring, but only after notification of all students participating in specimen collection.

DAT was performed by study personnel under the direction of Certified Doping Control Officers of the United States Anti-Doping Agency. Schools had provisions that students could have their personal physicians collect the specimen, on request. The athlete was escorted to the collection area by a same-gender tester. A modesty drape was placed across the bathroom stall, with the lower portion of their legs and upper torso visualized. No coats, jackets, purses, backpacks, or other items were allowed in the bathroom.

A minimum of 100 mL of urine was voided into the collection vessel containing an impregnated temperature strip, with detection levels between 90–100°F. Under the specimen collector's direction, the athlete transferred a sample (minimum 30 mL urine each) from the collection vessel into two separate specimen containers (A and B). The remaining portion was left in the collection vessel for sample quality assessment (pH and specific gravity). Any deviation from the expected range in temperature, pH (<5 or >7), or specific gravity (<1.010) required another sample.

A and B containers were sealed with tamper-evident tape containing a temporary specimen number. The student and observer signed the chain-of-custody form, certifying that the specimen was theirs. Specimens were sent to the laboratory without the subject's name. Schools were provided the same documentation, with the student name.

Specimen analysis methods

Specimen analysis was performed at Quest Diagnostic Laboratory, a certified DHHS laboratory. Specimens were analyzed for marijuana (THC metabolite), cocaine, amphetamines, opiates (including heroin), phencyclidine (PCP), benzodiazepines, barbiturates, LSD, and alcohol. Anabolic-androgenic steroids were assessed on every other sample (50% of the tests). Positive enzymatic immunoassay findings were confirmed with gas chromatography-mass spectrometry (GC/MS) testing [22–24]. If positive tests resulted from both the enzymatic and the GC/MS test analysis, students could request that the unopened B sample be analyzed at the same laboratory or by another laboratory of

their choice. All androgen tests used GC/MS methodology. Tests were considered positive below standard cutoffs, using lowest levels of detection. A breath test for alcohol was performed at the same time as the urine collection, using a U.S. Department of Transportation approved analyzer. Test result reports were sent to schools by secure fax.

Questionnaire administration

Surveys were administered at five separate time periods: during the beginning/fall and the end/spring of the 2000–2001 and 2001–2002 school years and during the fall of the 2002–2003 school year. Study staff distributed surveys in a classroom or auditorium setting. Each confidential questionnaire had an identifying face sheet with a bar code matching the survey pages. This identifier was voluntarily completed, separated from the survey instrument and collected by study staff. After questionnaire completion, students sealed their survey in an opaque envelope. Envelopes were collected and transported by research staff. The student's name was verified as a valid consented athlete, otherwise the survey was shredded.

Questionnaire measures

A 121-item questionnaire was developed from national surveys and our earlier studies [17,25–27]. To avoid misinterpreting a switch of one substance to another as an actual reduction in drug and or alcohol use, we created a drug use index, combining self-reported use of various drugs and an index that combined alcohol with those same drugs used in the drug use index. Each substance was assessed by self-report (Table 1).

For past month and year drug use, categories were constructed for different levels of use. Each drug use response was converted to counts of times using the drug. Counts were then summed, forming total times using any drug. Totals were categorized, forming the index: nonuse (0), light (1), moderate (2), and heavy use (3), done separately for each of the four indices representing drugs only or alcohol and drugs during the past month or past year. For example, for past month, nonuse was zero, light use was one or two times, moderate use, three or four, and heavy use, five or more.

To assess attitudes and risk and protective factors, individual items used seven-point Likert agreement scales. We grouped three or more items with acceptable reliability (Cronbach's standardized $\alpha > 0.7$) to form constructs assessing potential mediators, moderators, and proximal and distal program outcomes. The constructs and their standardized α results are shown in Table 2.

Data analysis

Group demographic differences were examined with ordinary least-squares regression for continuous variables and logistic regression for categorical variables. Baseline differences in drug use variables were estimated using a multilevel model that accounted for clustering of scores within schools.

Table 1
Baseline demographics and drug use variables

	Deferred (N = 743)	DAT (N = 653)
Demographics, mean (SD)		
Age, years	15.4 (1.1)	15.6 (1.2)***
Grade[a]	2.2 (1.0)	2.4 (1.1)***
Gender as % of males[c]	51.1 (1.8)	56.9 (1.9)*
Grade point average[b]	3.28 (.63)	3.31 (.57)
Race/ethnicity, % white[c]	91.2 (1.0)	90.0 (1.2)
Percent reporting any use in prior month		
Alcohol	20.7%	22.1%
Marijuana	4.8%	5.5%
Amphetamines	2.2%	1.9%
Narcotics	1.0%	1.1%
Sniffing glue	1.4%	.9%
Anabolic steroids	.3%	1.1%*
Diet pills	2.6%	2.2%
Percent reporting any use in prior year		
Alcohol	48.5%	49.1%
Marijuana	13.1%	16.2%
Amphetamines	5.7%	6.5%
Narcotics	2.8%	26.4%
Sniffing glue	3.1%	3.3%
Anabolic steroids	.4%	1.6%**
Diet pills	5.0%	4.6%

[a] Where 1 = freshman, 2 = sophomore, 3 = junior, and 4 = senior.
[b] Based on a 4.00 scale: 4 = A and 3.5 = B+.
[c] Standard error is reported for proportions.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Individual athletes' scores on each of the drug use indices and potential mediating variables were modeled across measurement occasions using multilevel models to account for the clustering of scores for the same individual across

Table 2
Questionnaire construct variables

Construct	No. of items	Reliability
Belief in own athletic competence	4	.80
Positive attitude toward school	6	.81
Positive attitude toward drug testing	3	.89
Belief in benefits of drug testing	5	.86
Perceived level of drug use among peers	4	.91
Belief peers are opposed to drug use	5	.81
Belief authorities are opposed to drug use	5	.78
Belief in the negative consequences of drug use	4	.74
Belief in the positive consequences of drug use	4	.85
Reactance toward drug testing	4	.74
Greater desire to take risks	3	.77
Belief in testing as a reason not to use drugs	5	.85
Belief their social group is more opposed to drug use	4	.79

Construct scores were the items summed and divided by the number of items. Scale items ranged from 1 to 7 for all measures except a 0–10 scale for perceived level of drug use among peers.

Table 3
Mean drug use index score by condition across time[a]

Substance use	Time 1	Time 2	Time 3	Time 4	Time 5
Past month illicit drug use					
Deferred	.207	.237	.168	.265	.261
DAT	.177	.237	.177	.276	.165
Past month illicit drug & alcohol use					
Deferred	.516	.663	.562	.649	.614
DAT	.558	.640	.572	.836	.627
Past year illicit drug use[b]					
Deferred	.358	.475	.410	.453	.431
DAT	.454	.417**	.447	.457	.305**
Past year illicit drug and alcohol use					
Deferred	.910	1.092	1.092	1.068	1.033
DAT	.980	.977*	.955*	1.055	.917

[a] Index scores range from 0–3, where 0 = no use and 3 = heavy use.
[b] Effect of treatment across time was significant, $F(4,36) = 4.22$, $p < .01$.
* $p < .05$ for *post hoc* contrast test of treatment from Time 1 to this time.
** $p < .01$.

time, and within schools across individuals [28,29]. These models do not require complete data for each individual at each time point [30]. The multilevel models had three levels: a variation in an individual's scores across time; a variation among individuals within schools, and a modeled variation between schools. Time was treated as a categorical predictor, allowing for scores at different times to be modeled separately, and individuals' scores at different times were modeled as a function of the treatment group (0 = control, 1 = DAT). Results are presented for an unconditional model, which reflected the first measurement not being a true baseline, as students were aware of their group assignment [31,32].

Results

Baseline data

Table 1 presents baseline demographics and past month and year use of selected substances for the two study groups, demonstrating similarities of these features for the randomized schools. Athletes in the deferred testing (comparison) schools were younger (3 months; $p < .001$) and at a lower grade. There was a higher percentage of males in the DAT group but no differences in GPA or ethnic/racial distribution.

At baseline, analysis of individual substances revealed that student-athletes in DAT schools reported higher 1-month prior use and 1-year past use of anabolic steroids than comparison schools. No differences were found among other individual substances between conditions. Past month self-reported indices of illicit drugs and illicit drugs and alcohol use were not significantly different between deferred and DAT schools ($F(1,9) = 0.16$, $p = .700$ [illicit drug use index]; $F(1,9) = 0.03$, $p = .872$ [illicit drugs and alcohol use index]), as shown in Table 3. Past year drug use and the combination of drugs and alcohol use were comparable as well ($F(1,9) = 0.52$, $p = .491$ [illicit drug use index]; $F(1,9) = 0.08$, $p = .783$ [drugs and alcohol use index]).

Effects on substance (illicit drug and alcohol) use

The treatment effect was tested for each of the four substance use indices using the model described above. In this model, the interaction of time and treatment is the treatment effect, as it indicates that the change in drug use index scores over time varied across deferred and DAT schools. This interaction effect was significant for only the index of past year illicit drug use (Table 3). The interaction was nonsignificant for both past month use indices and for the past year alcohol and drug use index. In addition to the overall interaction tests, contrasts were used to investigate at which time points deferred and DAT schools differed relative to their initial status. These contrasts showed significant effects at the first follow-up (Time 2) and at the last follow-up (Time 5; both $p < .01$) for past year drug use. At both of these follow-up periods, DAT schools had significantly lower mean past year drug use scores than did deferred schools. For combined drug and alcohol use, these were deterrent effects at the first and second follow-up ($p < .05$).

Attrition and sport participation

Over time, student survey attrition was expected from six sources: graduation, sports withdrawal, transfer, absence, survey refusal and study withdrawal. Sports rosters typically decrease during the first few weeks of the season because of quitting, roster limitations, or injury; thus true study attrition cannot be precise. Graduation of 12th-grade students was expected to reduce the yearly cohort by nearly 25% each year; with an additional school attrition set at

Table 4
Sample size and attrition versus expected sample size and attrition, by study group

	Fall 2000	Spring 2001	Fall 2001	Spring 2002	Fall 2002
Deferred N	743	599	409	393	249
% Retained		80.6	55.0	52.9	33.5
% from previous wave		80.6	68.3	96.1	63.4
DAT N	653	462	334	278	197
% Retained		70.8	51.1	42.6	30.2
% from previous wave		70.8	72.3	83.2	70.9
Expected % retained[a]		81.0	48.6	39.4	23.6

[a] Expected percentage retained is based on two sources of attrition within a school year (i.e., from a fall to a spring measurement) and two sources of attrition between school years (i.e., from a spring to a fall measurement). Within-year attrition is attributed to students leaving the school (10%) and students quitting school sports (10%). Between-year attrition is attributed to students leaving (moving and school dropout) the school (20%) and graduating (25%). For each treatment group, the first line shows sample size, the second shows the percentage retained from the first wave, and the third shows the percentage retained from the previous wave.

20%/school year (moving, changing schools); and dropout of sports set at 10%/year. Overall, attrition levels were as expected in control and intervention schools. Using the assumptions concerning anticipated attrition rate, the expected retention is shown on the bottom row of Table 4. Both conditions maintained comparable retention rates (differences of two to 10 surveys per school) for each follow-up questionnaire period. Sport participation rates did not differ for any school across study years, and no trends were reported for lower sport participation in DAT policy schools.

Mediating variables

Table 5 shows mediator scale means for control and DAT schools at baseline group by time interactions and the final assessment. Means differing significantly ($p < .05$) at baseline were that athletes in DAT schools believed less in the benefits of drug testing and scored higher on reactance. A significant treatment group by time interaction indicates that athletes in DAT schools had less belief in their athletic competence ($p < .001$), had less belief that authorities are opposed to drug use ($p < .01$), and had greater desire to take risks ($p < .05$).

From baseline to the final assessment, DAT students had less belief in their own athletic competence ($p < .001$) believed less in the benefits of testing ($p < .05$), believed that authorities were less opposed to drug use ($p < .001$), and believed less that testing was a reason not to use drugs ($p < .01$).

Discussion

The deterrent effect of drug and alcohol testing was present for the index of past year illicit drug use and combined drug and alcohol use, each at two follow-up time points. If DAT were to have an impact, the expected deterrent effect likely would be that the policy would alter recent (e.g., past month) use of drugs or drugs and alcohol, since student-athletes were under the threat of testing during that time period, but not during the summer months. However, no differences were noted at any of the four follow-up time points for past month indices of use of drugs or use of drugs and alcohol. With 16 opportunities overall to demonstrate a substance-use deterrent effect during 2 years and four follow-up assessments (Table 3), only four effects were significant. The significant effects for past year drug use and alcohol and drug use were not independent, as both scales included drug use.

There are limitations to this study. The assessments used to indicate past use were based on self-report measures, and some students may have underreported use. Although expected, there was sizable attrition over the course of the investigation. Furthermore, five schools were removed from the study, and two schools in the intervention changed from entire school year testing, to season-only testing, because of concerns after legal challenges.

The five schools initially removed from the study, were from the same school district, and their elimination occurred before surveys were completed and before any drug testing. Of these schools, two were intervention and three were comparison. The two schools that changed their policy after testing was initiated from full school year testing to season-only testing did so because of concerns after legal challenges during the first study year, and their results are not included because of this alteration in policy. They were the two smallest schools. Despite this, substance use indices for drugs and drugs and alcohol were similar among schools completing the study at baseline, ensuring we were evaluating student-athletes with similar substance use.

Also, the attrition levels were expected, and overall retention of student athletes were comparable across conditions. Differences in attrition/school questionnaires were between two and 10 subjects/school among DAT policy and comparison schools at each assessment.

The results did not suggest that students in DAT schools underreported their substance use, or that only a select group of student-athletes with more positive attitudes completed the surveys at any time point. In fact, at baseline, past month and past year self-reported use of anabolic steroids

Table 5
Construct variable mean scores at baseline and final assessment

	Baseline	Final assessment
Belief in own athletic competence***		
Control	6.0	5.6***
DAT	6.1	5.1
Positive attitude toward school		
Control	5.0	4.6
DAT	4.5	4.0
Positive attitude toward drug testing		
Control	4.5	3.8
DAT	4.0	3.3
Belief in benefits of testing		
Control	4.6^{+}	4.2*
DAT	4.1	3.4
Perceived level drug use among peers		
Control	4.3	4.3
DAT	4.8	4.8
Belief peers are opposed to drug use		
Control	5.0	4.6
DAT	4.8	4.2
Belief authorities are opposed to drug use**		
Control	6.4	5.9***
DAT	6.4	5.3
Belief in the negative consequences of drug use		
Control	6.0	5.3
DAT	5.8	4.9
Belief in the positive consequences of drug use		
Control	2.4	3.1
DAT	2.5	3.2
Reactance toward drug testing		
Control	2.5^{+}	3.3
DAT	3.0	3.7
Greater desire to take risks*		
Control	2.6	3.1
DAT	2.7	3.3
Belief in testing as a reason not to use drugs		
Control	4.5	4.1**
DAT	4.3	3.5
Belief their social group is more opposed to drug use		
Control	4.9	4.4
DAT	4.7	4.3

$^{+}$ Baseline differences between groups at $p < .05$. Any change over time between treatment and deferred policy (overall group by time interactions) are next to the construct name. Likewise, baseline to final assessment differences (next to final assessment means) are indicated by * $p < .05$, ** $p < .01$, *** $p < .001$. Scale is 1 = strongly disagree to 7 = strongly agree.

was higher among student-athletes in DAT randomized schools, despite student-athletes knowing they would be subject to DAT immediately after survey completion. Also, student-athletes in DAT schools reported less positive attitudes, after the policy was instituted, consistent with our pilot study findings [17]. At the final assessment, DAT athletes believed less in the benefits of drug testing, believed less that testing was a reason not to use drugs, and reported that school officials were less opposed to drug use than the students at comparison schools. This suggests that student-athletes in DAT schools were not a selected segment of students with positive attitudes and behaviors.

Because self-reports were confidential, but not anonymous, there may have been reporting bias by some athletes unwilling to provide accurate information [33]. Underreporting has been more prevalent among adults involved in certain drug testing situations [34]. However, when adolescents believe drug testing is present, they may be more inclined to report use when promised confidentiality than those not perceived to be involved in testing [35,36]. Our finding of greater self-reported recent use of steroids and no differences in use of other drugs or alcohol by those who knew they would be subject to drug testing after survey completion, suggests DAT school athletes did not differentially underreport.

The past year deterrent effects of DAT appeared to be intermittent, as noted at the second measurement, and the final assessment, but not in the year between. Lack of greater effects of DAT could be caused by the perception of the deterrent policy enacted by the schools. Students knew that they would remain on their team after their first offense if they attended a drug counseling session and adhered to its follow-up, that they would face no legal consequence or school sanctions, and that they would not have a permanent record of their test results. However, these policies are aligned with both the Oregon and federal courts and the White House Office of National Drug Control Policy [8,13,14,19]. This type of policy treats drug use as a health issue rather than a crime with attendant punishment [8]. If a student remains on a team and enters counseling, that student may be more apt to be helped than if excluded from sports and ostracized from the team and school. More restrictive policies may have different results, which could be a greater deterrent or, paradoxically, could lead to an increase substance use.

The attitudinal changes that occurred among students at DAT policy schools are of concern. The negative effect on certain potential substance-use mediators, including authorities less opposed to drug use, may signal potential future adverse effects of drug and alcohol testing. Although our two-school, nonrandomized pilot intervention revealed a reduction in past month use of drugs, this study, like the pilot, showed a negative impact on selected substance use mediators, albeit of small magnitude.

In a previous cross-sectional study of student drug testing [7], no difference was found in drug use between schools that reported a drug testing policy compared with schools without DAT. However, that study was not prospective and did not assess pretesting use levels, and the investigators did not document the number or frequency of tests or report the consequences of a positive test. Furthermore that evaluation combined schools with a myriad of testing policies, including random, voluntary, and "for cause" testing; and unfortunately the assessments included

students who were not even subject to testing, thereby confounding the analysis.

Two legal challenges arose during the course of the study. One asserted a study schools' DAT policy violated the Oregon State Constitution with regard to privacy [21,30]. The Circuit and Oregon Appeals Court voted unanimously in the school's favor [37]. On appeal, The Oregon Supreme Court denied two petitions, letting stand the lower court's decisions. A federal class action lawsuit was filed by one student [38,39]. The U.S. District Court dismissed 51 of the initial 53 defendants and nine of 10 claims [39]. The federal judge dismissed claims for fraud, conspiracy, negligence, lack of informed consent and various constitutional-type injuries [40]. The case resolved without payment to the student who initiated the lawsuit, nor was payment made to a second student who later joined the lawsuit [41].

Heightened concerns about adolescent substance abuse have fostered discussions about the institution of drug testing policies in schools. Although these findings may differ in other schools or regions of the United Sates, this study lends credence to some DAT deterrent effects, especially for past year use for drugs, at two time points, and for drugs and alcohol at two time points. However, because some substance abuse mediators appeared to worsen and past month substance use never changed, more research should be performed to assess the policy of drug and alcohol testing's overall effects.

Acknowledgments

This project was supported by a grant from the National Institute on Drug Abuse (DA-12018) (to L.G.). Supported in part by PHS grant 5 MO1 RR00334. Clinical Trials number (www.clinicaltrials.gov): NCT00451854. David MacKinnon, Ph.D., the study analyst, and Linn Goldberg, M.D., are independent of any commercial funding source, have had full access to all of the data in the study, and take responsibility for the integrity of the data and the accuracy of the data analysis. The authors sincerely thank the school boards, superintendents, principals, coaches, school staff, student-athletes and their parents involved in this study. The authors are also grateful for the expert legal counsel of Janet Billups, J.D., Timothy Volpert, J.D., Robert A. Schlacter, J.D., Mark A. Friel J.D., M.A., and the Institutional Review Board of the Oregon Health & Science University for their support.

References

[1] National Federation of State High Schools Associations. High school athletics participation breaks 7 million mark. 2005 http://www.aiaonline.org/story/uploads/Participation_Survey_Press_Release090105_1126103166.pdf.

[2] Aaron, DJ, Dearwater, SR, Anderson, R, et al. Physical activity and the initiation of high-risk health behaviors in adolescents. Med Sci Sports Exerc 1995;27:1639–42.

[3] Carr, CN, Kennedy SR, Dimick KM. Alcohol use among high school athletes. Prevention Researcher 1996;3:1–3.

[4] Garry JP, Morrissey SL. Team sports participation and risk-taking behaviors among a biracial middle school population. Clin J Sport Med 2000;10:185–90.

[5] Scott DM, Wagner JC, Barlow TW. Anabolic steroid use among adolescents in Nebraska schools. Am J Health Syst Pharm 1996;53:2068–72.

[6] Faulkner RA, Slattery CM. The relationship of physical activity to alcohol consumption in youth. Can J Public Health 1990;81:168–9.

[7] Yamaguchi, R, Johnston LD, O'Malley PM. Relationship between student illicit drug use and school drug-testing policies. J Sch Health 2003;73:159–64.

[8] Office of National Drug Control Policy, Drug Testing in Schools, 2002. Executive Office of the President of the United States, pp. 1–16.

[9] School-Based Drug Testing Programs, Office of Safe and Drug Free Schools. http://www.ed.gov/programs/drugtesting/index.html.

[10] Coombs RH, Ryan FJ. Drug testing effectiveness in identifying and preventing drug use. Am J Drug Alcohol Abuse 1990;16:173–84.

[11] Uzych L. Drug testing of athletes. Br J Addict 1999;86:25–31.

[12] Ferstle J. Evolution and politics of drug testing. In: Yesalis C, ed. Anabolic Steroids in Sport and Exercise. Champaign, IL: Human Kinetics, 1992.

[13] Vernonia School District 47 v Acton. 15 S Ct 2386, 1995.

[14] Board of Education v. Earls, No. 01-332, 2002.

[15] Albrecht RR, Anderson WA, McKeag DB. Drug testing of college athletes: The issues. Sports Med 1992;14:349–52.

[16] Steroid use drops among student athletes. NCAA News. September 1, 1993:1.

[17] Goldberg L, Elliot DL, MacKinnon DP, et al. Drug testing athletes to prevent substance abuse: Background and pilot study results of the SATURN (Student Athlete Testing Using Random Notification) study. J Adolesc Health 2003;32:16–25.

[18] Taylor R. Compensating behavior and the drug testing of high school athletes. Cato Journal 1997;16:1–12. Available at: http://www.cato.org/pubs/journal/cj16n3-5.html. Accessed September 14, 2007.

[19] Oregon School Boards Association Selected Sample Policy: Student athlete drug testing: 5/5/99. Available at: http://www.osba.org.

[20] Constitution of Oregon, Section 9. Unreasonable searches or seizures. Available at: http://bluebook.state.or.us/state/constitution/constitution01.htm.

[21] Weber v Oakridge School District 76, 184 Or. App. 415, 56 P. 3d 504 (2002). http://old.orcities.org/publications/focusSectionArchive.cfm?id=4&issueID=15.

[22] United States Department of Health and Human Services; Substance Abuse and Mental Health Services Administration, Division of Workplace Programs: Drug Testing. Federal Register; August 21, 2001. Available at: http://workplace.samhsa.gov/DrugTesting/SpecimenValidityTesting/federalreg.htm.

[23] Peat MA. Analytical and technical aspects of testing for drugs of abuse: confirmatory procedures. Clin Chem 1991;34:471–3.

[24] Visher C. A comparison of urinalysis technologies for drug testing in criminal justice. National Institute of Justice Research in Action. Washington, DC: US Department of Justice, National Institute of Justice; 1991.

[25] Goldberg L, Elliot D, Clarke GN, et al. Effects of a multidimensional anabolic steroid prevention intervention. J Am Med Assoc 1996:276;1555–62.

[26] Goldberg L, MacKinnon DP, Elliot DL, et al. The adolescents training and learning to avoid steroids program: Prevention drug use and

promoting health behaviors. Arch Pediatr Adolesc Med 2000;154: 332–8.
[27] Brener ND, Kann L, McManus MS, et al. Reliability of the 1999 Youth risk behavior survey questionnaire. J Adolesc Health 2002;31:336–42.
[28] Bryk AS, Raudenbush SW. In: Hierarchical Linear Models: Applications and Data Analysis Methods. Newbury Park, CA: Sage, 2002.
[29] Barcikowski RS. Statistical power with group mean as the unit of analysis. J Educ Stat 1981;6:267–85.
[30] Murray DM. In: Design and Analysis of Group-Randomized Trials. New York: Oxford University Press, 1998.
[31] Dwyer JH. In: Statistical Models for the Social and Behavioral Sciences. New York: Oxford University Press, 1983.
[32] Dwyer JH, MacKinnon DP, Pentz MA, et al. Estimating intervention effects on longitudinally observed health behaviors: The Midwestern Prevention Project. Am J Epidemiol 1989;130:125–43.
[33] Hser YI, Maglione M, Boyle K. Validity of self-report of drug use among STD patients, ER patients and arrestees. Am J Drug Alcohol Abuse 1999;25:81–91.
[34] Yacoubian GS Jr, VanderWall KL, Johnson RJ, et al. Comparing the validity of self-reported recent drug use between adult and juvenile arrestees. J Psychoact Drugs 2003;35:279–84.
[35] Wagenaar AC, Komro KA, McGovern P, et al. Effects of a saliva test pipeline procedure on adolescent self-reported alcohol use. Addiction 1993;88:199–208.
[36] Murray DM, Perry CL. The measurement of substance use among adolescents: When is the 'bogus pipeline' method needed? Addict Behav 1987;12:225–33.
[37] The Oregon State Supreme Court denied Certiorari in Weber v. Oakridge School District 69 P.3d 1233 (OR 2003). Court of Appeals ruling prevails. Weber v. Oakridge School District 76 Oregon State Supreme Court 16-00-21584; A114141 Appeal from Circuit Court, Lane County.
[38] OHSU, schools sued over drug testing study. Register-Guard, Eugene Oregon, July 15, 2002. 31.
[39] OREGON. Judge dismisses 9 Of 10 Claims V. University in Drug Test Suit. IBL Class Action Reporter, Tuesday, April 22, 2003, Vol 5, No. 78. Available at: http://bankrupt.com/CAR_Public/030422.mbx 32.
[40] U.S. district judge dismisses majority of claims in SATURN lawsuit. OHSU News and Information, April 15, 2003. Available at: http://www.ohsu.edu/news/2003/041503saturn.html.
[41] Settlement wraps up drug-test case. Andy Dworkin, The Oregonian, April 22, 2004.