Population-Level Administration of AlcoholEdu for College: An ARIMA Time-Series Analysis

Todd M. Wyatt, B.A.[1] William DeJong, Ph.D.[2] Elizabeth Dixon, M.A.[3]

[1] Director of Research, Outside The Classroom, Inc., 250 First Avenue, Suite 201, Needham, MA 02494; and doctoral candidate, Department of Psychology, George Mason University, 4400 University Drive, MS3F5, Fairfax, VA 22030

[2] Professor, Department of Community Health Sciences, Boston University School of Public Health, 801 Massachusetts Avenue, Third Floor, Boston, MA 02118; and Executive Director for Research and Analysis, Outside The Classroom, Inc., 250 First Avenue, Suite 201, Needham, MA 02494

[3] Prevention Coordinator, Counseling and Substance Abuse Services, Robert Scott Small Building, 175 Calhoun Street, College of Charleston, Charleston, SC 29424

Corresponding author: William DeJong, Ph.D.
Professor
Boston University School of Public Health
801 Massachusetts Avenue, Third Floor
Boston, MA 02118
Phone: (617) 414-1393
Email: wdejong@bu.edu

ABSTRACT

Objectives*:* ARIMA (Auto-Regressive Integrated Moving Averages) is a powerful analytic tool for conducting interrupted time-series analysis, yet it is rarely used in studies of public health campaigns or programs. This study demonstrated the use of ARIMA to assess AlcoholEdu® for College, an online alcohol education course for first-year students, and other health and safety programs introduced at a moderate-size public university in the South.

Participants: From 1992-2009, the university administered annual Core Alcohol and Drug Surveys to samples of undergraduates (N's = 498 to 1032).

Methods: AlcoholEdu and other health and safety programs that began during the study period were assessed through a series of quasi-experimental ARIMA analyses.

Results: Implementation of AlcoholEdu in 2004 was significantly associated with substantial decreases in alcohol consumption and alcohol- or drug-related negative consequences. These improvements were sustained over time as succeeding first-year classes took the course.

Conclusion: Previous studies showed that AlcoholEdu has an initial positive impact on students' alcohol use and associated negative consequences. This investigation suggests that these positive changes may be sustainable over time through yearly implementation of the course with first-year students. ARIMA time-series analysis holds great promise for investigating the impact of program and policy interventions to address alcohol-and drug-related problems on campus.

Running Head: Time-Series Analysis of AlcoholEdu for College

Key Words: alcohol; alcohol prevention; college students; high-risk drinking; time-series analysis; ARIMA

Alcohol use by US college students continues to be a pressing national problem, resulting in an estimated 1,825 deaths among students ages 18-24 in 2005.[1] In response, campus administrators have implemented a mix of prevention strategies, including basic alcohol education,[2,3] brief motivational interviewing,[4] social norms marketing,[5,6] and revised campus and community alcohol policies.[7]

Historically, educational programs—including orientation sessions for new students, alcohol awareness weeks, and curriculum infusion—have been viewed as the least effective of these strategies. In 2002, the National Institute on Alcohol Abuse and Alcoholism (NIAAA) Task Force on College Drinking declared that basic awareness and education programs were ineffective when used in isolation.[8] A more recent review by Larimer and Cronce[9] drew the same basic conclusion.

The past decade has seen the development of a new approach to education: the use of internet-based interventions to provide alcohol education to first-year students. AlcoholEdu® for College, developed by Outside The Classroom, Inc., is one example. This comprehensive course uses a variety of interactive formats to teach students the factual information, concepts, and behavioral skills they need to make informed choices about drinking.[2] Key content includes: 1) factors that cause blood alcohol concentration (BAC) to rise rapidly, 2) negative health, safety, and academic consequences that can result at varying BAC levels, 3) the benefits of abstaining or drinking at safer levels, 4) challenges to positive expectancy beliefs regarding the behavioral, emotional, and cognitive effects of alcohol, 5) social and media influences on student alcohol use, 6) data on actual student drinking norms, to correct students' misperceptions, 7) current alcohol and anti-drunk driving laws, and 8) cognitive and behavioral strategies for decreasing alcohol consumption and maintaining BAC in a safer range.

Recent evaluations have shown that online courses can be effective in reducing high-risk drinking and its negative consequences. For example, Hustad and colleagues[3] conducted a randomized control trial that compared the two most widely used electronic interventions,

AlcoholEdu for College (version 9.0) and e-CHUG (Electronic Check-Up to Go), which provides personalized feedback and other prevention-related information. At one-month follow up, both interventions led to significant reductions in alcohol use when compared to an assessment-only control group, however, only AlcoholEdu showed significantly fewer alcohol-related consequences. Within-group effect sizes for the three groups were as follows: AlcoholEdu (*d* = .32), e-CHUG (*d* = .08), and assessment-only control group (*d* = -.26). A randomized control study that examined an earlier version of AlcoholEdu (version 8.0) also showed positive effects on alcohol use and negative drinking consequences at 30-day follow up.[2]

To date, evaluations of commercially available online programs have not demonstrated long-term impacts on student drinking. With e-CHUG, a randomized control trial showed that, after 8 weeks, heavy drinkers showed significant reductions in alcohol consumption, but not alcohol-related problems. By week 16, however, the assessment-only group reached the same level of improvement as the e-CHUG group. The program had no effect on abstainers or light drinkers.[10] Another study showed that, at three-month follow up, students with a previous drinking history who took the course College Alc reported greater decreases in heavy drinking and negative alcohol-related consequences compared to a control group. In contrast, students in both groups with no previous drinking history reported increased negative consequences.[11] Studies of College Alc with longer term follow-up periods have not yet been done.

Computerized personal feedback delivered by non-commercial programs similar to e-CHUG have been shown to reduce college student drinking after five to six months.[12,13] Investigations with longer follow-up periods are logistically possible. In a related study, for example, students randomly assigned to complete an internet-based survey received a personalized feedback report in the mail, plus a series of ten weekly postcards that provided prevention tips and reinforced generic content from the mailed feedback report. Compared to an assessment-only control group, students who received this intervention reported less drinking on a survey completed fully one year later.[14]

Another strategy for assessing the long-term impact of online alcohol education is to conduct an interrupted time-series analysis of drinking-related outcomes at individual colleges and universities that have implemented a course for several years.[15,16] A particular set of conditions is necessary to conduct a meaningful time-series study. First, there must be data that has been collected both continuously and consistently from well before implementation of the course to the present day. Second, the course must be used to provide universal education (e.g., to all first-year students), with high rates of student participation. Third, the course itself must be the primary intervention that was introduced at the time of first implementation and for subsequent years.

ARIMA (Auto-Regressive Integrated Moving Averages) is a powerful analytic tool for conducting quasi-experimental interrupted time-series analyses, yet it is rarely used in studies of public health campaigns or programs. The purpose of this study was to demonstrate the use of ARIMA to assess AlcoholEdu for College and other health and safety programs introduced at a moderate-size public university in the South.

We utilized the university's annual surveys of student alcohol use, which were conducted independently of the course. With only first-year students taking AlcoholEdu, we did not expect the course to be associated with an immediate and substantial decrease in the entire student body's self-reported alcohol use. Instead, we hypothesized that initially there would be a small-to-moderate improvement, which would then increase year by year as succeeding first-year classes took the course. Eventually, we thought, there would be a critical mass of students who had completed the course, making it possible for a sustainable culture around healthier drinking behaviors to emerge.[17]

METHODS

The present study utilized ARIMA (Auto-Regressive Integrated Moving Averages) to conduct a series of interrupted time-series analyses to evaluate AlcoholEdu,[18-20] with the pre- vs. post-intervention time periods treated as the primary independent variable and alcohol use and alcohol- and drug-related negative consequences reported by students in annual surveys from 1992-2009 serving as the dependent variables. We conducted similar analyses to assess other health and safety programs that the university introduced during this time period.

Program Implementation

The university administered AlcoholEdu to all incoming first-year students beginning in 2004. Students were invited to take the course before matriculation, but could continue to enroll during the first month of classes. An email invitation told students they were expected to take the course, but they were not penalized if they failed to complete it. Completion rates over six administrations (2004-2009) averaged 71.7%, with a range of 58.3% to 88.1%.

As described in more detail below, the university conducted its Core Alcohol and Drug survey each November to assess student alcohol use. This means that, in 2004 and in subsequent years, the first-year students took AlcoholEdu two or more months *before* the university administered the annual survey.

ARIMA makes it possible to detect trends in a time series and to determine at what point in time a trend reaches statistical significance, taking into account what occurred prior to each time point. In effect, ARIMA makes it possible to ascertain when there is a significant shift while controlling for the trending at earlier time points. Accordingly, we also assessed other student safety and wellness programs that were implemented during the study period. Programs of interest included the following (year of initiation is noted in parentheses):

1. *Peer Education* (2002), with education programs conducted by trained undergraduate and graduate students at on-campus informational events. That same year, the university

launched a *Student Information Website*, “Better Things to Do,” which presents alternative activities, program descriptions, sources of assistance, and basic information on alcohol and other drug abuse.

2. *College Community Coalition* (2003), a collaboration with nearby colleges, local government, law enforcement, and prevention and treatment centers to provide alternative recreational programs for students (e.g., climbing wall, late-night concerts). That year the university also began its *Campus Action Team*, a campus-wide initiative involving administrators, staff, faculty, and students to design and implement environmental management strategies for alcohol prevention.

3. *Silent Witness (*2005), an anonymous online crime reporting system.

4. *Peer Counseling* (2006), one-on-one sessions conducted by trained undergraduates via telephone or in person to provide support and service referrals for students in distress.

Survey Data

From 1992 to 2009, the university administered the Core Alcohol and Drug Survey, an anonymous self-report survey designed to assess college student attitudes, behaviors, and negative consequences, with a primary focus on alcohol. The Core Institute at Southern Illinois, which developed the survey, has documented that the instrument has good psychometric properties, including high test-retest reliability.[21,22]

Each year, with the exception of 1996, university administrators invited the entire undergraduate student body to complete the survey in November, toward the end of the fall semester, well after the first-year students had completed AlcoholEdu for College. Completion rates averaged 9.7%, with a range of 7.2% to 13.4%. While these completion rates are very low, the demographic characteristics of the survey samples remained relatively consistent across the study period. Hence, there is little evidence to suggest that different types of students responded to the survey across the years, making the data suitable for time-series analysis.[15,16]

Overall, about two thirds of the students were female; nearly 90% were 18-22 years of age; and just under one third were first-year students (see Table 1). According to data provided by the university's office of institutional research, across the several academic years examined in the study, there were only a few instances where a Core Survey sample differed significantly from the student body as a whole (see Table 1). These data suggest that the survey samples are representative of the overall university population

The Core Survey includes several questions about alcohol and other drug use. We examined the percentage of students who reported any alcohol consumption during the past 30 days, as well as the percentage of underage students (younger than 21 years) who did so. We also looked at the percentage of students who said they had used alcohol in the past week (in response to a customized question added by the university).

Students reported how many times over the last two weeks they had "five or more drinks at a sitting," a measure of heavy episodic drinking, with a drink defined as "a bottle of beer, a glass of wine, a wine cooler, a shot glass of liquor, or a mixed drink." We examined the percentage of students who reported this level of alcohol consumption one or more times.

Students indicated how often they had experienced several negative consequences due to their drinking or drug use during the last year. We examined the percentage of students who reported each of the following experiences one or more times: had a hangover; performed poorly on a test or important project; been in trouble with police, residence hall, or other college authorities; got into an argument or fight; driven a car while under the influence; missed a class; thought might have a drinking or other drug problem; had a memory loss; did something later regretted; and been taken advantage of sexually.

Key demographic variables included gender (male or female); race/ethnicity (American Indian/Alaskan Native, Hispanic, Asian/Pacific Islander, White (non-Hispanic), Black (non-Hispanic), or Other; age; classification (freshman, etc.); and grade-point average (F to A+).

The university administered the annual Core Surveys with approval of its Institutional Review Board. The analyses reported here were conducted on aggregated statistics reported in internal university documents.

Statistical Analysis

Typically, cross-sectional time-series data does not lend itself well to typical ordinary least squares (OLS) regression analysis. The primary difficulty is that time-series data are often inherently autocorrelated, meaning that temporally successive observations and their associated error terms are not statistically independent from each other. This violates a key assumption underlying OLS regression and increases the risk of overestimating the statistical significance of the predictor variables (Type I error). The ARIMA time-series method, initially suggested by Box and Jenkins,[16] minimizes the temporal impact of autocorrelated data on the error terms and thereby reduces the risk of Type I error.[18,20]

Another advantage to using ARIMA is the possibility of incorporating an interruption (or impact) variable in order to model the effect of a new program, policy, or other change that is introduced during the study period. This can be done by creating an independent dummy variable, where a value of 0 is assigned before the change is in effect (pre-intervention), and a value of 1 is assigned during times when the change is in effect (post-intervention. This analysis strategy has significant advantages over other approaches. In a time-series design, the impact of an intervention may not be instantaneous, but gradual. This pattern of results would be undetectable in a more conventional cross-sectional design, but can be handled easily using ARIMA.[15,18,20]

ARIMA models are defined by three parameters labeled *p, d,* and *q*, expressed as ARIMA (*p*,*d*,*q*). The *number of autoregressive terms* ("autoregressive component") (*p*) specifies the extent to which time-series values are affected by preceding values, meaning that the data

are autocorrelated. A value of *p* = 0 means that the data have no autocorrelation. A value of *p* = 1 means that the time-series values are being affected by the immediately previous value, and that the model should be adjusted by adding a time-lag term that controls for that. The *number of nonseasonal differences* ("integrated component") (*d*) specifies whether and what type of adjustment is needed to achieve stationarity, whereby the mean value of the dependent variable remains constant over the entire time series. A value of *d* = 0 means that the data are stationary; *d* = 1 means that there is a linear trend and *d* = 2 means there is a quadratic trend that must be accounted for in the ARIMA model. The *number of lagged forecast errors in the prediction equation* ("moving average component") (*q*) specifies whether an adjustment is needed to account for lagged effects of random shocks in the time series. A value of *q* = 0 means there are no shocks. In the present study, virtually all of the variables could be modeled using ARIMA (0,1,0),

ARIMA time-series analysis results in the calculation of the statistic Stationary R^2, which estimates the proportion of the total variation in the trend line that is explained by the model. Stationary R^2 values can range from negative infinity to 1. Negative values indicate that the model is worse than a simple mean model, while positive values indicate that the model performs better than a simple mean model. In short, large positive values indicate better fit. The Ljung-Box Q statistic indicates whether there is any non-random structure in the observed trend that is not accounted for by the model; a p-value *greater* than 0.05 indicates that the model is correctly specified.

The data available for this investigation included only 17 time points, with annual Core Surveys available for 1992 to 2009, except for 1996. With ARIMA, missing data can be problematic, especially when the number of time points is relatively small. Indeed, SPSS Predictive Analytics Software (PASW*,* version 18.0 for Windows)[23] limits the use of ARIMA to time series with 20 or more time points.

To impute missing data, SPSS employs an interpolative process recommended by Jones[24] for ARIMA (see also Yaffee[20]). We used this imputation procedure to estimate missing values for 1990, 1991, and 1996, bringing the total number of data points up to 20. The imputed data gave the ARIMA method sufficient degrees of freedom (df = 18) to determine if our models are correctly specified (Ljung-Box Q) and to detect the proportion of variation explained by the model (Stationary R^2). We repeated the ARIMA time-series analyses with data imputed for 1991, 1996, and 2010 and obtained similar results, which are not reported here.

ARIMA can detect at what point in time a trend reaches statistical significance by determining if the change seen at one point in time is significantly different from what had occurred previously, taking into account the mean values at all previous time points and not just the most recent preceding time point. Because of this, it is possible to assess whether decreases in alcohol-related outcomes seen in 2004 when AlcoholEdu was first implemented represent a statistically significant change compared to all previous years. Likewise, it is possible to assess whether decreases seen in any year before 2004, when other programs were first implemented, represent a statistically significant change compared to all previous years. In this way, interventions introduced in different years can be directly compared.

RESULTS

Table 2 shows the results for the ARIMA time-series analyses for student-reported alcohol consumption and alcohol- or drug-related negative consequences. We assessed all of the listed variables for cross-sectional change over the time series and the association of the implementation of AlcoholEdu with that change. The implementation of AlcoholEdu was associated with positive outcomes on several key measures.

Figures 1-3 display the time-series data for the 1990-2009 time period, with dashed lines inserted to highlight the fact that in 2004, and in subsequent years, first-year students took AlcoholEdu two or more months *before* the university administered its annual Core Survey.

Thus, the data shown for 2004 and each subsequent year reflect any changes that are associated with AlcoholEdu. All three figures show decreases between 2003 and 2004, the year when the AlcoholEdu course was first implemented.

When interpreting these figures, it is important to remember that ARIMA makes it possible to detect trends in a time series and to determine at what time point a certain trend reaches statistical significance. In Figure 2, for example, there is a slight downward trend in the percentage of students who reported having driven a car while under the influence of alcohol that began in 1999, but this trend is not statistically significant. This declining trend did not reach statistical significance until after the first implementation of AlcoholEdu in 2004.

Alcohol Consumption

As illustrated in Figure 1, the implementation of AlcoholEdu was associated with a significant and immediate decrease in alcohol consumption. We found a moderate increase in the percentage of students who reported *alcohol use in the past 30 days* between 1991 and 2003 and then a significant decrease between 2003 and 2004, the year when the university first used AlcoholEdu. The ARIMA (0,1,0) model indicated that implementation of AlcoholEdu was associated with a significant decrease in reported consumption (Stationary R^2= .420; Box-Ljung Q18: 9.86, p =.94). Examining the percentage of students participating in *underage alcohol use in the past 30 days*, the ARIMA (0,1,0) model also indicated a significant downturn in 2004, after the initial implementation of AlcoholEdu (Stationary R^2 = .259; Box-Ljung Q18: 10.18, p =.93).

The percentage of students who reported *drinking alcohol in the past week* followed a similar pattern: a moderate increase between 1991 and 2003, with a shift downward in 2004 that continued through 2009 (Stationary R^2 = .425; Box-Ljung Q18: 10.47, p =.92). Likewise, the ARIMA model for the percentage of students who reported *heavy episodic drinking*, defined as consuming 5-plus drinks at a sitting in the last two weeks, also showed a significant decrease in 2004 (0,1,0; Stationary R^2= .492; Box-Ljung Q18: 19.69, p =.29).

Alcohol- or Drug-Related Negative Consequences

We next examined student reports of alcohol- or drug-related negative consequences (see Table 2). The ARIMA time-series analysis revealed no significant change at the implementation point for AlcoholEdu for three measures: got into a fight or argument (0,1,0); did something later regretted (1,1,0); and had a memory loss (0,1,0).

ARIMA time-series models (0,1,0) did show that between 2003 and 2004, following implementation of AlcoholEdu, there was a reduction in the percentage of students who reported the following six alcohol- or drug-related negative consequences. Results for these first three measures are illustrated in Figure 2: been in trouble with police, residence hall, or other college authorities (Stationary R^2= .283; Box-Ljung Q18: 11.80, p =.86); driven a car while under the influence (Stationary R^2= .265; Box-Ljung Q18: 16.83, p =.54); and thought might have a drinking or other drug problem (Stationary R^2 = .282; Box-Ljung Q18: 18.73, p =.41). Results for these additional three measures are illustrated in Figure 3: performed poorly on a test or important project (Stationary R^2 = .202; Box-Ljung Q18: 12.29, p =.83); missed a class (Stationary R^2 = .288; Box-Ljung Q18: 12.99, p =.79); and had a hangover (Stationary R^2= .336; Box-Ljung Q18: 17.20, p =.51).

Additional Prevention Programming

We also conducted ARIMA time-series analyses to investigate the other safety and wellness programs put in place between 1992 and 2009 (see the Methods section for descriptions).

In 2002, the university implemented Peer Education and a Student Information Website. ARIMA time-series analyses (0,1,0) revealed that the implementation of these efforts was associated with significant increases in students' self-reported grade-point average (Stationary

R^2 = .272; Box-Ljung Q18: 23.83, p =.16) and significant decreases in the prevalence of missing a class due to alcohol or drug use (Stationary R^2= .202; Box-Ljung Q18: 17.16, p =.52).

In 2003, the university implemented two programs, a College Community Coalition and a Campus Action Team. ARIMA time-series models showed no significant changes associated with the implementation of these efforts, though there was a near-significant association for students' reports of being taken advantage of sexually. Two years later, in 2005, the university implemented the Silent Witness program. The ARIMA time-series analyses (0,1,0) showed that its implementation was associated with a significant decrease in students' reports of being taken advantage of sexually (Stationary R^2 = .266; Box-Ljung Q18: 18.89, p =.40).

Finally, in 2006, the university initiated its Peer Counseling program. The ARIMA time-series analysis (0,1,0) showed that its implementation was significantly associated with a decrease in the percentage of students who reported drinking in the past 30 days (Stationary R^2= .314; Box-Ljung Q18: 10.87, p =.90).

COMMENT

ARIMA time-series analyses revealed that the year in which AlcoholEdu was first implemented was associated with significant decreases in alcohol use and alcohol- or drug-related negative consequences. Previous studies showed that AlcoholEdu has an initial positive impact on students' alcohol use and associated negative consequences.[2,3,17] This investigation suggests that these positive changes may be sustainable over time when succeeding first-year classes take the course.

The primary source of data was the university's annual Core Alcohol and Drug Survey, which was completed each year by members of all four undergraduate classes. We had not expected the course to be associated with immediate and substantial decreases in the entire student body's alcohol use. Across several variables, however, implementation of the course

was associated with small to moderate decreases, and then that trend continued to increase as succeeding classes took the course.

We also investigated several additional programs implemented during the same time period. Implementation of these programs was associated with a fraction of the decreases associated with the AlcoholEdu course. There were moderate downturns in alcohol use, plus some favorable changes in alcohol- or drug-related consequences, but in general these interventions were associated with few significant effects, either immediately or gradually over time. It is important to point out that the decreases associated with AlcoholEdu may be at least partially due to the combined impact of the multiple, targeted programs already in place when the course was first implemented in 2004.

Study Limitations

There were four limitations presented by use of the university's annual student surveys. First, as noted previously, the survey completion rates were quite low throughout the study period. Importantly, there was no evidence that the demographic profiles of the students who completed the surveys varied from year to year, which rendered the data still suitable for time-series analysis.[12,13]

Second, time-series analysis requires that the time interval between the data be small enough to properly capture the process being studied.[12] In the current investigation, the available time points were at yearly intervals, which raises some degree of concern. However, this is counterbalanced by the fact that the surveys were administered at the same time each year using a consistent methodology. Thus, while having more frequent time points would have strengthened the analysis, we do not believe that the temporal distance between the time points significantly compromised our ability to conduct this investigation.

Third, the number of firm time points available for the ARIMA analyses fell below the optimal number needed to eliminate threats to internal validity.[17] As a result, we had to impute

data for three years (1990, 1991, and 1996). Data imputation is common in time-series analysis,[24] but having to do this in order to create a sufficient number of data points to conduct the analysis was not optimal.

Fourth, the data available for this investigation did not allow for the inclusion of comparison sites to account for possible alternative historical impacts and other threats to internal validity.[17] Obtaining outcome data from multiple institutions that would be suitable for time-series analysis is a formidable challenge, but not having comparison sites nonetheless limits the degree to which we can conclude that it was the implementation of AlcoholEdu that brought about the significant outcome changes that were found rather than other factors. It is true that single-unit ARIMA models are weaker than ones involving comparison sites, but they nevertheless offer valuable insight into time-series phenomena.[15]

Future Research

ARIMA time-series analysis holds great promise for investigating the long-term impact of online alcohol education and other types of program and policy interventions to address alcohol- and drug-related problems on campus. Additional investigations are clearly warranted. The alternative strategy—conducting multi-year randomized control trials—is often impracticable, due to the difficulty of sustaining a control group over several years and the extremely high cost of conducting such studies.

Unfortunately, future ARIMA-based studies will be inhibited by the general unavailability of reliable and valid indicator data that has been collected over a long period of time. Few colleges have done annual student surveys for several years, and fewer still have useful archival records (e.g., hospital transports, arrests, residence hall complaints, building damages). For their own purposes, campus administrators need to do a better job of collecting and analyzing these types of data,[25] and as they do so, opportunities for future ARIMA time-series studies will open up.

REFERENCES

1. Hingson RW, Zha W, Weitzman ER. Magnitude of and trends in alcohol-related mortality and morbidity among U.S. college students age 18-24, 1998-2005. *J Stud Alcohol Drugs Suppl*. 2009;16:12-20.

2. Lovecchio CP, Wyatt TM, DeJong W. Reductions in drinking and alcohol-related harms reported by first-year college students taking an online alcohol education course: A randomized trial. *J Health Comm*. 2010; in press.

3. Hustad JTP, Barnett NP, Borsari B, Jackson KM. Web-based alcohol prevention for incoming college students: A randomized controlled trial. *Addict Behav.* 2010;35:183-189.

4. Baer JS, Kivlahan DR, Blume AW, McKnight P, Marlatt GA. Brief intervention for heavy drinking college students: Four-year follow-up and natural history. *Am J Public Health*. 2001;91:1310–1316.

5. DeJong W, Schneider SK, Towvim LG, Murphy MJ, Doerr EE, Simonsen N.R, Mason KE, Scribner RA. A multisite randomized trial of social norms marketing campaigns to reduce college student drinking. *J Stud Alcohol*. 2006;67:868-879.

6. Turner JC, Perkins HW, Bauerle J. Declining negative consequences related to alcohol misuse among students exposed to a social norms marketing intervention on a college campus. *J Am Coll Health*, 2008;57:85-93.

7. Weitzman ER, Nelson TF, Lee H, Wechsler, H. Reducing drinking and related harms in college: Evaluation of the "A Matter of Degree" program. *Am J Prev Med*. 2004;27:187-196.

8. National Institute on Alcohol Abuse and Alcoholism (NIAAA), Task Force of the National Advisory Council on Alcohol Abuse and Alcoholism. *A Call to Action: Changing the Culture of Drinking at U.S. Colleges*. Washington, DC: National Institutes of Health; 2002.

9. Larimer ME, Cronce JM. Identification, prevention, and treatment revisited: Individual-focused college drinking prevention strategies." *Addict Behav*. 2007*;*10:1999–2006.

10. Walters ST, Vader AM, Harris TR. A controlled trial of web-based feedback for heavy drinking college students. *Prev Sci*. 2007;8:83-88.

11. Bersamin M, Paschall MJ, Fearnow-Kenney M, Wyrick D. Effectiveness of a web-based alcohol-misuse and harm-prevention course among high- and low-risk students. *J Am Coll Health*. 2007;55:247-254.

12. Lewis MA, Neighbors C, Oster-Aaland L, Kirkeby BS, Larimer ME. Indicated prevention for incoming freshmen: Personalized normative feedback and high-risk drinking. *Addict Behav*. 2007;32:2495-2508.

13. Neighbors C, Larimer ME, Lewis MA. Targeting misperceptions of descriptive drinking norms: Efficacy of a compter-delivered personalized normative feedback intervention. *J of Con & Clin Psych*. 2004;72:434-447.

14. Larimer ME, Lee CM, Kilmer JR, Fabiano, PM, Stark CB, Geisner IM, Mallett KA, Lostutter TW, Cronce JM, Feeney M, Neighbors C. Personalized mailed feedback for college drinking prevention: A randomized clinical trial. *J of Con & Clin Psych*. 2007;75:285-293.

15. Shadish WR, Cook TD, Campbell D.T. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Boston, MA: Houghton, Mifflin, & Company; 2002.

16. Box GEP, Jenkins GM, Reinsel GC. (1994). *Time-Series Analysis: Forecasting and Control* (3rd ed.). Englewood Cliffs, NJ: Prentice Hall; 1994.

17. Wall A. Evaluating a health education web site: The case of AlcoholEdu. *NASPA Journal*. 2008;44:692-714.

18. McCain LJ, McCleary R. The statistical analysis of the simple interrupted time-series quasi-experiment. In TD Cook, DT Campbell (Eds.), *Quasi-Experimentation Design and Analysis Issues for Field Settings*. Boston, MA: Houghton, Mifflin, & Company; 1979, 233-293.

19. McDowall D, McCleary R, Meidinger E, Hay R. (1980). *Interrupted Time-Series Analysis*. Beverly Hills, CA: Sage Publications; 1980.

20. Yaffee R. *Introduction to Time-Series Analysis and Forecasting: With Applications of SAS and SPSS*. San Diego, CA: Academic Press; 2000.

21. Presley CA, Meilman PW, Lyerla R. *Alcohol and Drugs on American College Campuses: Use, Consequences, and Perceptions of the Campus Environment*. Carbondale, IL: Southern Illinois University; 1993.

22. Presley CA, Meilman PW. Development of the Core Alcohol and Drug Survey: initial findings and future directions. *J Am Coll Health*. 1994;42:248–256.

23. SPSS, Inc. *PASW Forecasting 18.0 for Windows*. Chicago, IL, SPSS; 2009.

24. Jones RH. Maximum likelihood fitting of ARMA models to time-series with missing observations. *Technometrics*. 1980;22:389-395.

25. DeJong W, Langford LM. *Evaluating Environmental Management Approaches to Alcohol and Other Drug Abuse Prevention*. Washington, DC: U.S. Department of Education, Higher Education Center for Alcohol and Other Drug Abuse and Violence Prevention; 2006.

Table 1. Sample Demographic Characteristics and Core Survey Sample Size (1992-2009)

Demographic Variable	Survey Year																	
	1992	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Gender: % female	70	70	(61)	66	(63)	67	69[a]	70	63	62	63	64	71	77	78	73	73	74
Race/ethnicity: % White	89	88	(81)	87	(86)	86	(85)	87	86	82[a]	84	84	82	85	87[a]	84	88	81
Age: % 18-22 years	87	83	N/A	85	N/A	87	85	87	88	90	91	87	89	88	87	86	85	87
Classification: % freshmen	35	26[a]	(28)	30	(27)	35	(25)	22	36	36	37	20	30	28	28	25[a]	23	34
Core Survey sample size	626	498	N/A	1148	N/A	512	946	984	1424	899	1032	989	823	900	816	856	951	906

Note: Figures in parentheses indicate data obtained from the university's office of institutional research and not from the Core Surveys due to missing data. N/A = data not available.

[a] The difference between the Core Survey sample and the entire university student body is statistically significant ($\mathcal{O}^2$, $p < .05$).

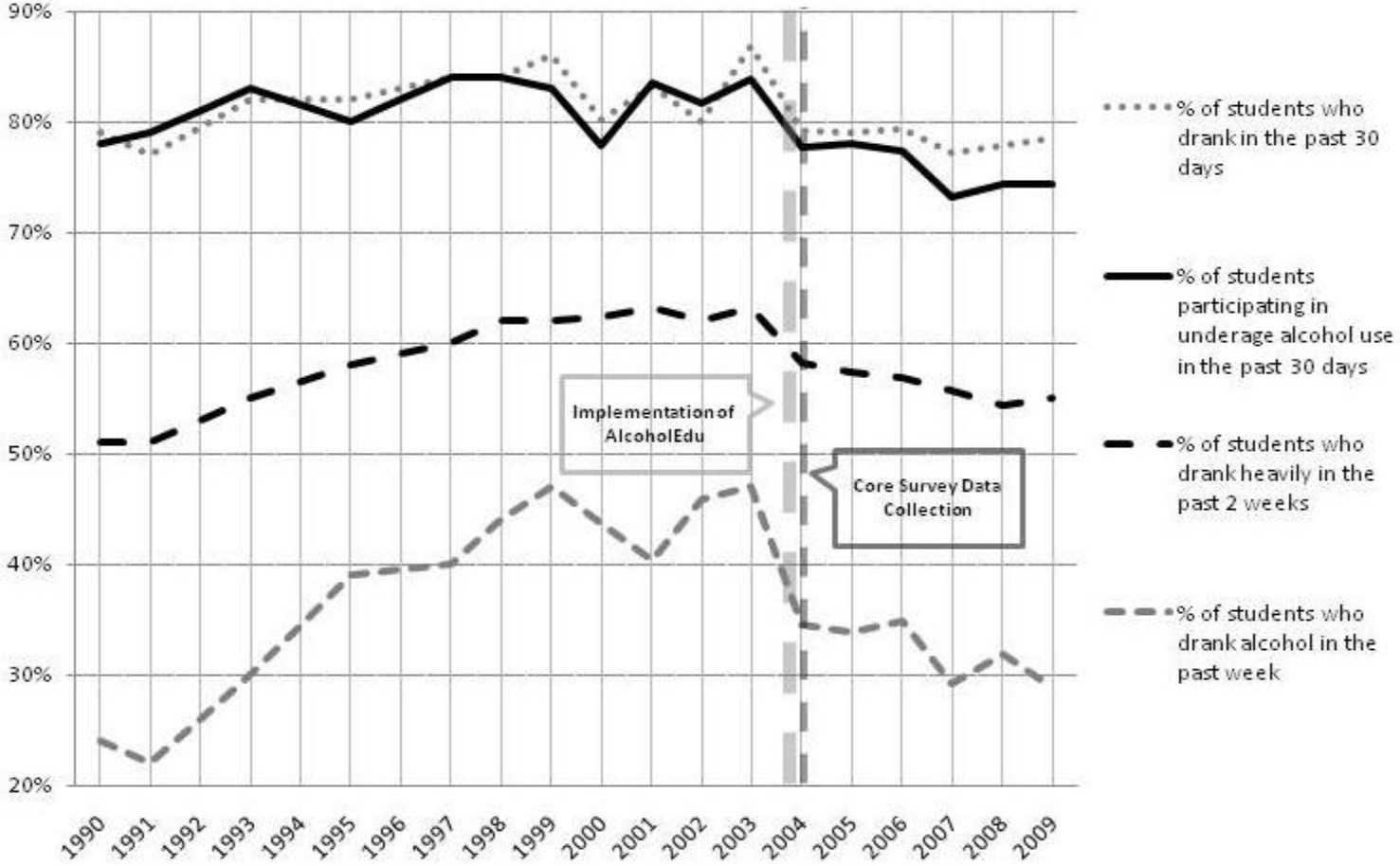
Table 2: Association of AlcoholEdu with Decreases in Student-Reported Alcohol Consumption and Alcohol- and Drug-Related Consequences

Outcome (% of Students)	Model Type (p,d,q)	Stationary R^2	Estimate (SE)	*t*	*p*-value
Alcohol Consumption					
Drank alcohol in the past 30 days	ARIMA (0,1,0)	*.420*	*-.088 (.011)*	*-3.61*	*.002*
Participated in underage drinking in the past 30 days	ARIMA (0,1,0)	*.259*	*-.092 (.024)*	*-2.55*	*.020*
Drank alcohol in the past week	ARIMA (0,1,0)	*.425*	*-.145 (.034)*	*-3.69*	*.002*
Engaged in heavy episodic drinking (5+ drinks at a sitting)	ARIMA (0,1,0)	*.492*	*-.061 (.012)*	*-4.24*	*.000*
Alcohol- and Drug-Related Consequences					
Had a hangover	ARIMA (0,1,0)	*.336*	*-.064 (.021)*	*-3.03*	*.007*
Performed poorly on a test or important project	ARIMA (0,1,0)	*.202*	*-.091 (.029)*	*-2.13*	*.047*
Been in trouble with police, residence hall, or other college authorities	ARIMA (0,1,0)	*.283*	*-.035 (.013)*	*-2.68*	*.015*
Got into an argument or fight	ARIMA (0,1,0)	*.185*	*-.039 (.019)*	*-2.03*	*.058*
Driven a car while under the influence	ARIMA (0,1,0)	*.265*	*-.096 (.037)*	*-2.59*	*.019*
Missed a class	ARIMA (0,1,0)	*.288*	*-.069 (.025)*	*-2.72*	*.014*
Thought might have a drinking or other drug problem	ARIMA (0,1,0)	*.282*	*-.040 (.015)*	*-2.70*	*.015*
Had a memory loss	ARIMA (0,1,0)	*.000*	*NT*	*1.21*	*.143*
Did something later regretted	ARIMA (1,1,0)	*.273*	*NT*	*2.54*	*.243*

Been taken advantage of sexually	ARIMA (0,0,0)	*.002*	*1.00 (.983)*	*1.02*	*.332*

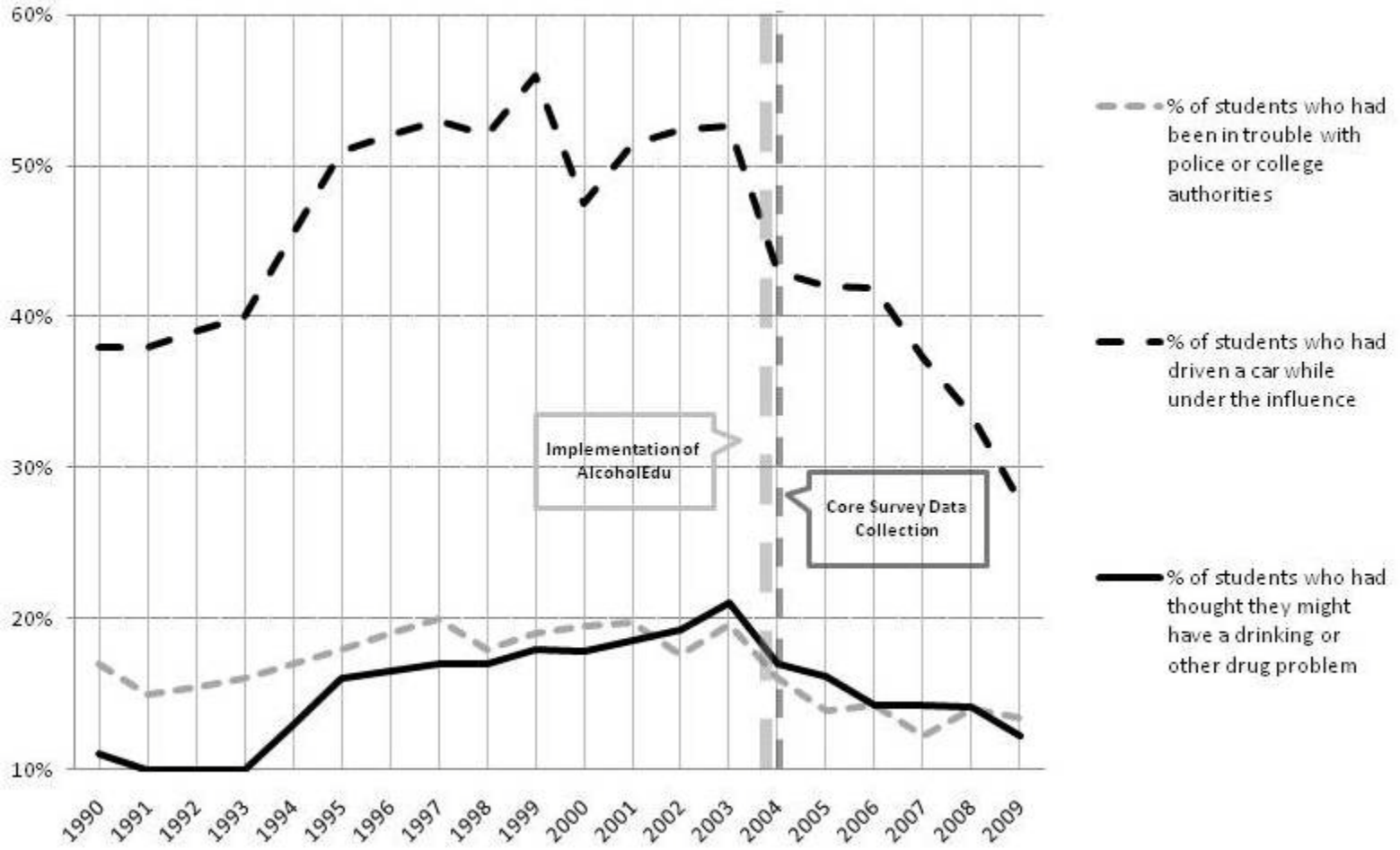
Note: The type of ARIMA model used is indicated by the number of autoregressive terms (*p*), the number of nonseasonal differences (*d*), and the number of lagged forecast errors in the prediction equation (*q*). Estimate = Estimated value of the intervention parameter; SE = Standard error of the intervention estimate; NT = No Transformation—i.e., implementation of AlcoholEdu did not cause a significant transformation in the ARIMA model.

Figure 1: Interrupted Time-Series for Measures of Alcohol Consumption



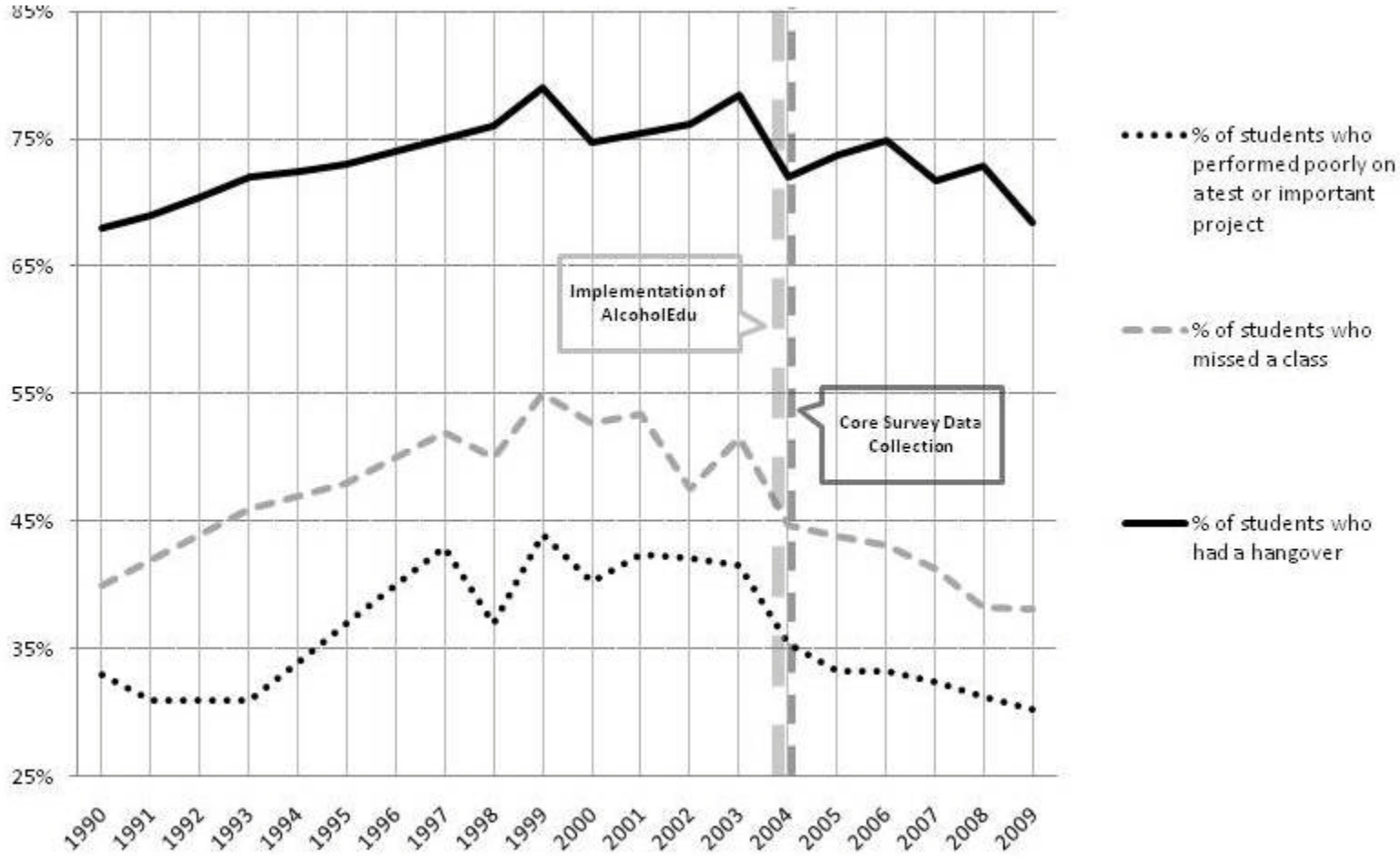
Note: Data from years 1990 and 1991 were estimated by using data imputation. The vertical dashed lines highlight the fact that in 2004, and in subsequent years, first-year students took AlcoholEdu two or more months before the university administered its annual Core Survey. Thus, the data shown for 2004 and each subsequent year reflect any changes that are associated with AlcoholEdu.

Figure 2: Interrupted Time-Series for Major Alcohol- or Drug-Related Consequences



Note: Question: "Please indicate how often you have experienced the following due to your drinking or drug use during the last year…" The percentage of respondents who reported a consequence one or more times is shown. Data from years 1990 and 1991 were estimated by using data imputation. The vertical dashed lines highlight the fact that in 2004, and in subsequent years, first-year students took AlcoholEdu two or more months before the university administered its annual Core Survey. Thus, the data shown for 2004 and each subsequent year reflect any changes that are associated with AlcoholEdu.

Figure 3: Interrupted Time-Series for Alcohol- or Drug-Related Academic and Physical Consequences



Note: Question: "Please indicate how often you have experienced the following due to your drinking or drug use during the last year…" The percentage of respondents who reported a consequence one or more times is shown. Data from years 1990 and 1991 were estimated by using data imputation. The vertical dashed lines highlight the fact that in 2004, and in subsequent years, first-year students took AlcoholEdu two or more months before the university administered its annual Core Survey. Thus, the data shown for 2004 and each subsequent year reflect any changes that are associated with AlcoholEdu.