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Impact of a Randomized Campus/Community Trial to Prevent High-Risk Drinking among College Students

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Abstract

Background—High-risk drinking by college students continues to pose a significant threat to public health. Despite increasing evidence of the contribution of community-level and campus-level environmental factors to high risk drinking, there have been few rigorous tests of interventions that focus on changing these interlinked environments. The Study to Prevent Alcohol Related Consequences (SPARC) assessed the efficacy of a comprehensive intervention using a community organizing approach to implement environmental strategies in and around college campuses. The goal of SPARC was to reduce high-risk drinking and alcohol-related consequences among college students.

Methods—Ten universities in North Carolina were randomized to an Intervention or Comparison condition. Each Intervention school was assigned a campus/community organizer. The organizer worked to form a campus-community coalition, which developed and implemented a strategic plan to use environmental strategies to reduce high-risk drinking and its consequences. The intervention was implemented over a period of 3 years. Primary outcome measures were assessed using a web-based survey of students. Measures of high-risk drinking included number of days alcohol was consumed, number of days of binge drinking, and greatest number of drinks consumed (all in the past 30 days); and number of days one gets drunk in a typical week. Measures of alcohol-related consequences included indices of moderate consequences due to one's own drinking, severe consequences due to one's own drinking, interpersonal consequences due to others' drinking, and community consequences due to others' drinking (all using a past 30-day timeframe). Measure of alcohol-related injuries included (1) experiencing alcohol-related injuries and (2) alcohol-related injuries caused to others.

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Results—We found significant decreases in the Intervention group compared to the Comparison group in severe consequences due to students' own drinking and alcohol-related injuries caused to others. In secondary analyses, higher levels of implementation of the intervention were associated with reductions in interpersonal consequences due to others' drinking and alcohol-related injuries caused to others.

Conclusions—A community organizing approach promoting implementation of environmental interventions can significantly affect high-risk drinking and its consequences among college students.

Introduction

Alcohol use is pervasive among college students in the United States (NIAAA, 2002). For example, in 2009 40% of full-time college students reported consuming five or more drinks in a row—often termed "binge" or "heavy episodic" drinking—in the two weeks preceding the survey (Johnston et al., 2010). College students typically drink more than their same-aged peers, and have not experienced the declines observed in adolescents and young adults not enrolled in college since the early 1980s (Grucza et al., 2009; Nelson et al., 2009).

High-risk drinking among college students is associated with a variety of harmful consequences. These include unintentional injury resulting from drinking and driving and other causes, physical and sexual assault, health problems, unsafe and unplanned sexual activity, sexual harassment, impaired sleep and study time, and interpersonal problems (Hingson et al., 2009; Nelson et al., 2009).

There is increasing recognition that college drinking affects not only the drinker, but others as well. "Second-hand" consequences associated with high-risk drinking by college students include injuries caused by other students' drinking, interruption of sleep and study, verbal harassment, being assaulted, and a general degradation of the on-campus environment (e.g., vomit in residence halls, vandalism) (Wechsler et al., 2000b; Wechsler & Wuethruch, 2002; Hingson et al., 2002; Yu, 2001; Jackson et al., 2005; Rhodes et al., 2009).

Most interventions addressing high-risk drinking by college students have focused on individuals or small groups. These efforts typically seek to affect knowledge, attitudes, or behavior related to high-risk drinking (Boyd & Faden, 2002; Larimer & Cronce, 2007). Although educational programs that simply provide information have little evidence of effectiveness (Larimer & Cronce, 2007), there is stronger support for the efficacy of well-designed and well-implemented cognitive-behavioral skills training and motivational enhancement approaches (Larimer & Cronce, 2007; NIAAA, 2002; Fromme et al., 1994; Kivlahan et al., 1990; Baer et al., 1992). Unfortunately, these approaches often have limited scope and reach, and may not be well suited to addressing the problem of high-risk college drinking at the population level.

High-risk drinking by college students is influenced by environmental factors, as well as the intrapersonal and interpersonal factors targeted by interventions focused on individuals and small groups (DeJong & Langford, 2002; Toomey & Wagenaar, 2002). For example, in an ecological analysis of eight communities in which the colleges and universities that participated in the A Matter of Degree Program (described below) were located, Weitzman and colleagues found that the density of alcohol outlets was highly correlated with heavy drinking, frequent drinking, and drinking-related problems among college students (Weitzman et al., 2003a; also see Wechsler et al., 2002). In another study, Weitzman and colleagues found that students who reported that they were exposed to social, residential, and market environments in which alcohol was prevalent, cheap, and easily accessible were more likely than other students to binge drink in their freshman year (Weitzman et al.,

2003b). Recent research has also found an association between levels of alcohol-outlet density and rates of sexual violence on campus (Scribner et al., 2010). And, finally, it has been suggested that environmental characteristics, such as high alcohol outlet density, may actually mute or negate the impact of other prevention efforts, such as social norms campaigns (DeJong et al., 2009).

A number of controlled community trials have demonstrated that communities can be mobilized to change environmental factors related to alcohol use and alcohol-related problems, leading to reductions in rates of use and problems. The Community Trials Project, which included intervention communities in northern California, southern California, and South Carolina, was designed to reduce alcohol-related injuries and deaths (Holder et al., 1997). This trial resulted in significant reductions in sales of alcohol to underage persons; self-reports of heavy drinking and driving after drinking; and alcohol-related motor vehicle crashes in intervention communities (Holder et al., 1997; 2000). The Communities Mobilizing for Change on Alcohol (CMCA) project was a randomized community trial testing the efficacy of community organizing, policy, and enforcement efforts designed to reduce youth access to alcohol. The CMCA intervention resulted in reductions in self-reported drinking by 18 to 20-year-olds; decreased propensity of on-premise alcohol outlets to sell alcohol to minors, and decreases in arrest and traffic crash indicators (Wagenaar et al., 2000a; Wagenaar et al., 2000b).

A few recent studies suggest that an environmental change strategy implemented on college campuses can result in reductions in high-risk drinking and alcohol-related problems. A Matter of Degree (AMOD) was a Robert Wood Johnson Foundation-funded demonstration program that used a community coalition-based approach to change local and campus environments that promote heavy alcohol use. In an evaluation of this initiative, 10 intervention colleges were compared with 32 control campuses. Among the five sites with high program implementation, significant improvements over time were seen in difficulty obtaining alcohol, frequency and amount of alcohol consumption, some alcohol-related consequences, and rates of driving after drinking and riding in a car with someone who had been drinking (Weitzman et al., 2004; Nelson et al., 2005). In a second study, which used a two-campus, quasi-experimental non-equivalent comparison group design, an environmental prevention campaign to reduce driving under the influence (DUI) by college students was found to result in significant declines in self-reported DUI (Clapp et al., 2005). Finally, in a trial in 14 public universities in California, Saltz and colleagues (2010) found that implementation of environmental prevention strategies focused on settings where heavy drinking events occur resulted in reduced rates of intoxication among college students.

In summary, there is a compelling need to develop and rigorously evaluate effective interventions for reducing levels of problem drinking by college students. Recent research points strongly to the potential effectiveness of an approach that focuses on both the campus and the community environment. The Study to Prevent Alcohol Related Consequences (SPARC) utilized a rigorous, randomized community trial design to test an approach in which community organizing was used to promote the development and implementation of environmental strategies on college campuses and in the surrounding community.

Materials and Methods

Recruitment and Randomization of Schools

Participation was limited to North Carolina schools in order to provide a uniform state legal environment with respect to alcohol sales, purchase, and possession, and to enable the study team to provide extensive trainings and technical assistance to participating schools. All four-year, liberal arts colleges and universities in North Carolina with 2,500 or more full-

time undergraduates, and with at least 20% of students living on-campus, were considered for inclusion. Military schools, single-gender schools, and seminaries or "Bible" schools were excluded. Eligible schools were surveyed by the study team, and were assigned a "readiness score" based on eight factors: existence of a task force or coalition to address alcohol use on campus; inclusion of the college/university president or designee on this task force; inclusion of a community representative on the task force; frequency of task force meetings; external funding to address alcohol use; previous training in environmental strategies; changes implemented as a result of environmental training; and a plan to institute environmental training in the future (O'Brien et al., 2005–2006). The goal was to identify schools that scored in the mid-range on this survey, indicating that they had the capacity to implement the SPARC intervention, but that doing so would not duplicate initiatives already in place.

Of the 14 NC schools that met our criteria, 13 agreed to a site visit by SPARC study team members to more thoroughly assess the school's readiness to participate in an environmental intervention in the context of a research study. Of the 13 schools visited, one declined to participate, another's enrollment had not been accurately reported and did not meet our minimum enrollment criteria, and one was a dry campus located in a dry county. The remaining 10 schools agreed to participate.

A matching process was used before randomization in order to achieve balance between schools in the intervention and comparison conditions. Balance was a concern because of the small number of schools to be randomized (Murray, 1998). Undergraduate enrollment and readiness survey scores were used to partition the 10 schools into small (≤ 6000 undergraduate students) and large schools, and schools that were more ready (≥ 2.2 on the readiness survey scale) and less ready (< 2.2). Two schools were classified as small and higher on the readiness scale; two were small and lower on readiness; four were larger and higher on readiness; and two were larger and lower on readiness. Schools were randomly selected within each of these four cells to be assigned to either the intervention or comparison group.

Intervention

The SPARC intervention used a community organizing approach to promote the development and implementation of environmental strategies on college campuses and in the surrounding community (Wagoner et al., 2010). The community organizers were employees of the university (one was housed in the student affairs office, three were in the counseling center, and one was in student health services). Each university provided office space on campus and immediate supervision by a campus administrator. The SPARC study team provided funding for a full-time organizer on each campus as well as a monthly budget of $300 ($10,800 over 3 years) to support coalition building and the development and implementation of the coalition's strategic plan. The SPARC study team hosted a monthly conference call with the organizers to discuss coalition progress, obstacles, and critical issues, and to provide study updates. In addition, the study team enabled the organizers to hold monthly conference calls to network with each other.

Study team members monitored coalition progress and provided on-going technical assistance to the organizers. In addition, the study team conducted 12 in-depth trainings over three years, which included content on the SPARC research design and methods, the environmental approach and environmental strategies, community organizing principles and methods, coalition building, strategic planning, media advocacy, involving retailers, conducting social norms campaigns, and sustainability.

The organizing process was divided into five stages: community assessment, coalition building, strategic planning, action, and sustainability. While the stages were somewhat sequential, progression through the stages was not unidirectional--the organizer and coalition could move back to an earlier stage, as needed (Wagoner et al., 2010). Intervention activities that took place in each of the stages are described below.

Assessment—The organizers used an existing assessment guide to identify and rate the relative importance of factors that contribute to alcohol use and its consequences on their individual campuses (Ryan et al., 1997). They assessed the problem of alcohol use and the power structures and dynamics of each campus. The organizers used existing school-specific data sources (see Presley et al., 1994; Department of Education, 1990) as well as primary data collected as part of SPARC (the College Drinking Survey, described below) to develop a comprehensive picture of alcohol use and related problems on each campus.

Coalition Building—Following the approaches used in two previous community trials that used a community organizing approach (Blaine et al., 1997; Wagenaar et al., 1999), each organizer conducted extensive relational meetings (also known as “one-on-ones”) with stakeholders, and recruited coalition members based on their interest in the issue of college drinking and on the resources and skills they could contribute to the coalition (median number of relational meetings = 107). A coalition was formed at each campus, with a membership of between 11 and 33 individuals (mean = 21). Coalitions included campus administrators, faculty, and staff (mean = 61%); students (mean = 14%); and community members (mean = 25%) (see Wagoner et al., 2010 for additional details on relational meetings and recruitment of coalition members).

Strategic Planning—The SPARC study team developed a matrix of “best and most promising” environmental strategies based on the literature on reducing high-risk drinking and associated consequences on college campuses (NIAAA, 2002; OJDDP, 1998; Toomey & Wagenaar, 2002; DeJong & Langford, 2002). Each site’s plan was required to include strategies from at least three of the four areas in the matrix: (1) alcohol availability, (2) harm minimization, (3) social norms and (4) alcohol price and marketing. In order to ensure that coalitions took a comprehensive approach, the study team required that strategic plans include awareness, enforcement and policy elements. Coalitions took between five and ten months to develop their strategic plans. The SPARC study team reviewed and, after any needed modifications, approved each plan. Table 1 summarizes the strategies included in the strategic plans.

Action—After strategic plans were approved, coalitions began implementing strategies to reduce high-risk drinking and related consequences. Across the five schools, one off-campus institutional policy and 11 campus policies were adopted. At one school, all local law enforcement agencies agreed to donate 16 hours per month to increase compliance checks and alcohol enforcement during high-risk times. The campus policies included increased sanctions for student alcohol violations; benefits for students in good standing; new late night programming; ban on alcohol flyers in residence halls; restrictions on alcohol paraphernalia; inter-departmental procedures for better communication and reporting; dual judicial policies to address off-campus behavior; and clarity on student code of conduct. With respect to enforcement, three schools reported 13 enforcement operations, including party patrols (n=2), compliance checks (n=2), saturation patrols/DWI checkpoints (5), and other (4).

In addition, three schools implemented comprehensive social norms marketing campaigns (3 schools, one school implemented a safe rides program, one school secured a commitment

from area landlords to track student alcohol violations in apartment complexes, one school hosted meetings with area retailers to improve responsible service practices; one school engineered increasing communication and collaboration between campus and community law enforcement and one school established up a "Citizen Scholars program" where privileges (e.g., preferential campus housing and parking spots) were tied to clean alcohol records.

Sustainability—The organizers and coalitions worked on a variety of activities related to sustainability, including securing commitment by the board of trustees to fully fund a coalition-initiated Safe Rides program; conducting meetings with top and mid-level campus administrators to promote long-term support of coalition activities; applying for grant funds; and discussions with a local non-profit agency exploring the incorporation of SPARC into the mission of the agency.

In summary, a community organizer was hired for each of the five intervention schools, who conducted an assessment of their campus and community and built a coalition consisting of campus officials, community members, and students. The organizer and coalition at each intervention school developed a strategic plan of environmental strategies, including awareness, enforcement, and policy elements. Schools moved into the action phase in the final 12 months of SPARC, working to implement the environmental strategies included in their strategic plan and to move towards sustainability.

Data Collection

Primary outcome measures were assessed using the College Drinking Survey (CDS), a web-based survey of students developed for SPARC that included new items as well as items used in previous studies of alcohol use and alcohol-related problems among college students and underage youth (Wechsler et al., 1994; Presley et al., 1994; Wolfson et al., 2004; Preisser et al., 2003; Wagenaar et al., 2000a; DeJong et al., 2006; Kolbe, 1990). (Complementary data from two additional data sources, a resident advisor survey and incident and injury reports, are reported elsewhere.)

The CDS was fielded four times: fall 2003 (baseline), fall 2004 (1st follow up), fall 2005 (2nd follow up), and fall 2006 (3rd follow up). The study used a repeated cross sectional design. For each fielding, a random sample of approximately 1200 undergraduate students (300 from each classification [freshman, sophomores, juniors, and seniors]) attending the ten universities was invited to complete a web-based survey. The goal under the study design was to have 416 students (104 per class) from each university complete the survey. The number of students invited to participate was based on the expectation from previous studies that approximately 30–35% of students who were sent an invitation would complete the survey within the allotted time period (approximately 4 weeks) (Reed, Wang, Shillington, Clapp, & Lange, 2006).

Each randomly selected student was sent an email inviting him or her to participate in the web-survey. The email informed the student about the details of the study and provided a link to a secured web site where the survey could be completed. The email notification protocol, which included up to five reminders, was based on the Dillman (2000) approach (Mitra et al., 2007). All students who completed the survey were sent emails awarding them $10.00 in PayPal dollars with instructions on how to deposit these funds into their checking or savings account. In each year of the survey, one participant at each school won $100 in a lottery conducted as an additional incentive for participation.

Response rates varied over the course of the four fieldings: 31.0% in 2003, 31.3% in 2004, 25.8% in 2005, and 22.6% in 2006. We compared demographics of our sample with

publically available school-level demographics for each participating college (University of North Carolina, 2006). There were no significant differences between our sample and the population of undergraduate students in terms of freshman status and race/ethnicity. Females were slightly overrepresented in our sample compared to their numbers in the population of undergraduate students at the study colleges ($p<.05$).

All data collection measures and protocols were approved by the Wake Forest University School of Medicine Institutional Review Board (WFUSM IRB). Several of the schools participating in the study also required IRB review and approval or set up oversight agreements with the WFUSM IRB.

Measures

Ten primary outcome measures from the CDS were grouped into three categories:

Measures of high-risk drinking

1. Number of Days Drank Alcohol (past 30 days)
2. Number of Days Binge Drinking (defined as four or more drinks in a row for females and five or more for males; past 30 days)
3. Number of Days Drunk in a Typical Week
4. Greatest number of Drinks Consumed in a Row (past 30 days).

Alcohol-related Consequences: Four groupings of alcohol-related consequences were measured, including two indices of past 30 day consequences from the student's own drinking and two indices of past 30 day consequences due to others' drinking:

1. Moderate Consequences Due to Own Drinking. Items used in calculating values for this index included: got drunk, had memory loss, had a hangover, did something later regretted, passed out, got into a verbal argument, rode with driver under the influence, missed a class, urinated in public, got sick/vomited, strained a relationship, drove a car under the influence, damaged property, was hurt or injured, and performed poorly on test or project.
2. Severe Consequences Due to Own Drinking. Items used in calculating values for this index included: required medical treatment, received a ticket for DUI/DWI, involved in an automobile/motorcycle accident, got into a physical fight, got into trouble with police, victim of a crime, had sex later regretted, was taken advantage of sexually, and took advantage of another sexually.
3. Interpersonal Consequences Due to Others' Drinking. Items used in calculating values for this index included: pushed, hit or assaulted; threatened with physical violence; physical fight; verbal argument; taken advantage of sexually; victim of sexual assault/rape; harassed due to sexual orientation, race/ethnicity, religion, or gender; personal property or residence damaged; victim of another crime.
4. Community Consequences Due to Others' Drinking. Items used in calculating values for this index included: had sleep or studying interrupted; found cans, bottles, or other litter in or around own residence; found vomit in or around own residence; considered transferring to another school.

The methods used for construction of these scales have been described previously (Rhodes et al, 2009). Briefly, factor analysis was used to consider dimensionality while Cronbach's alpha or KR-20 was used to consider reliability (internal consistency). Higher scores indicator greater frequency of alcohol-related consequences in the past 30 days.

Alcohol-related Injuries: Two groups of alcohol-related injuries requiring medical treatment were measured:

1. Experienced Alcohol-Related Injuries: automobile, motorcycle, bicycle, or all-terrain vehicle accidents; pedestrian hit by own motor vehicle; fall from height; sexual assault injuries; non-sexual assault injuries; stab wound, gunshot wound, burn, or other serious injury.
2. Caused Alcohol-Related Injuries to Others: automobile, motorcycle, bicycle, or all-terrain vehicle accidents; pedestrian hit by own motor vehicle; fall from height; sexual assault injuries; non-sexual assault injuries; stab wound, gunshot wound, burn, or other serious injury.

Measurement of Site-Level Dose

In community-based intervention trials, program implementation is likely to vary across sites, in part by design (as a generic intervention is tailored to local conditions), in part because of differences in the capacity and motivation of implementing sites, and in part because of exogenous factors (Wagenaar and Wolfson, 1993; Sorensen et al., 1998). There is increasing recognition that measuring "dose" of the intervention at the site level is often needed in order to document variation in implementation across sites and to enable researchers to conduct secondary analyses that take into account variable implementation (Weitzman et al., 2004; Hingson et al. 2005; Hallfors et al., 2002; Easterling et al., 2005). It is also important to assess the level of naturally occurring intervention at comparison or control sites.

In SPARC, the Environmental Strategy Implementation Survey (ESIS) was used to collect data at the five Intervention sites and the five Comparison sites to be used in constructing measures of implementation at the site level. The survey was emailed to the university contact for the SPARC study on each campus. The survey was self-administered, and was completed by the SPARC contact person on each of the 10 campuses in fall 2006.

The ESIS was used to assess each school's inputs and processes related to the SPARC model. Examples of inputs included having paid staff working on environmental strategy implementation, training received by that staff, and external funding for reducing alcohol use by students. Examples of processes included conducting a systematic assessment of factors contributing to alcohol use on campus, having a campus-community coalition focused on alcohol use, involvement of a wide range of campus officials and community members in that coalition, and actual implementation of environmental strategies.

Implementation scores were generated using an expert rating process. Five study team members served as raters, using ESIS data as the basis for their ratings. The raters were blinded with respect to the school and condition (Intervention or Comparison) reflected in the survey data. Each reviewer assigned each school ratings for individual items measuring intervention *inputs* (i.e., resources allocated to support implementation of an environmental approach to high risk drinking on the campus) and on the five stages of the community organizing *process* : assessment, coalition building, strategic planning, action, and sustainability. The SPARC model was used as a yardstick, with ratings assigned using a five point scale, with 1 = no more than would be expected of a "typical" campus; 2 = slight approximation of the SPARC model; 3 = modest approximation of the SPARC model; 4 = strong example of the SPARC model; and 5 = exceptional example of the SPARC model. The Shrout-Fleiss inter-rater reliability was 0.97 for the five raters.

The five raters' scores for *inputs* were averaged, by school, to generate a single *inputs* score for each school. For the *process* measure, raters' scores for each dimension were averaged

by school, and then the resulting scores for each dimension were themselves averaged to yield a single *process* score for each school. Because the resulting global measures of *inputs* and *process* were highly correlated (Spearman rho = 0.93), a principal components analysis was performed. This analysis resulted in one component that accounted for 93.9% of the variation in the *inputs* and *process* measures. The principal component was used in secondary analyses of outcome data examining the extent to which outcomes were related to this measure of implementation of SPARC (or, in the Comparison schools, activities resembling the SPARC intervention).

Analyses

All four waves of data from the CDS (fall 2003-fall 2006) were incorporated into analyses presented below. The intraclass correlation induced by randomization on the campus level was accounted for in all analyses using a mixed model approach (Murray, 1998, 2001; Murray and Short, 1995; Koepsell et al., 1991; Donner, Birkett, and Buck, 1981). The intervention effect was represented by the condition by time interaction for each of the 10 outcomes (described previously), which, if significant, would indicate that the difference between Intervention and Comparison schools was significant over time from baseline. A two-sided *P*-value<0.05 was considered to be statistically significant. Random coefficient models were compared to trend ANCOVA analyses in order to assess whether there was significant school heterogeneity (Murray, 1998). The results presented here are based on a random coefficients modeling approach, which was indicated by improved model fit using AIC (Murray, 1998; Burnham et al., 2002). School-specific time trends were characterized with linear terms in the random-coefficient modeling, allowing for heterogeneity in school trends over time. Three of the outcomes were dichotomized based on their distributions (i.e., low prevalence)--*Severe Consequences Due to Own Drinking, Experienced Alcohol-related Injuries*, and *Caused Alcohol-related Injuries to Others*--and were analyzed using logistic models. Analyses were adjusted for student gender, race, and academic classification.

In secondary analyses, the principal component derived from the ESIS (described previously) was included in the models to test for two-way interactions of site-level dose x time. Condition was not included in these models. Analyses were again adjusted for student gender, race, and academic classification.

All analyses were performed using SAS v. 9.2 (SAS Institute, Cary, NC).

Results

Pretest Equivalence

Blocked randomization resulted in good balance on school-level factors, including readiness score (Intervention mean = 2.4, Comparison mean = 2.3; p = 0.80); undergraduate, fulltime enrollment (Intervention mean = 8,153, Comparison mean= 9,611; p=0.67); and public/ private status (four state schools and one private school in each condition). In addition, communities in which the colleges were located did not differ significantly with respect to measures of population size and urbanity/ruralness, racial and ethnic composition, and socioeconomic status across the Intervention and Comparison conditions. Randomization also resulted in comparability at baseline between the sample of students in the Intervention and Comparison schools--there were no significant differences between the students in each condition with respect to academic classification (i.e., year in school), gender, race/ethnicity, past 30-day alcohol use, binge drinking, and getting drunk in a typical week (see Table 2).

Main Effects

Results of the main effects analyses are presented in Table 3. None of the measures of drinking show a significant group by time interaction. One of the measures of alcohol-related consequences—*Severe Consequences due to Own Drinking*—show a significant group by time interaction (p=.02). The negative coefficient for this variable indicates that these consequences decreased over time among students in the Intervention schools compared to students in Comparison schools. This variable is an index reflecting students experiencing any of several consequences as a result of their own drinking: requiring medical treatment, receiving a ticket for DUI, being involved in a motor vehicle accident, getting into a physical fight, getting into trouble with police, being a victim of a crime, having sex that was later regretted, being taken advantage of sexually, and taking advantage of another sexually.

In addition, we found a group by time interaction for *Alcohol-Related Injuries Caused to Others* (p=.03). Again, the estimated coefficient for this variable is negative, indicating reductions in over time for students in Intervention schools compared to those in Comparison schools. This variable is an index based on students reporting causing any of the following injuries to others as a result of the student's own drinking: motor vehicle or bicycle accident, pedestrian hit by your motor vehicle, fall from height, sexual assault injuries, non-sexual assault injuries, stab wound, gunshot wound, burn, or other serious injury.

Site-Level Dose

Schools' *inputs* and *process* scores are depicted in Figure 1. Each of the 10 schools is plotted on a graph, based on their *inputs* score (Y-axis) and *process* score (X-axis). The Intervention schools all cluster in the upper right corner, indicating that they are high or relatively high on both *inputs* and *process*. The exception is Intervention School 2, which fell in the "modest approximation of the SPARC model" range with respect to *process*. There is considerably more variability in the Comparison schools. Two of the Comparison schools (Comparison School 2 and Comparison School 5) were low on both *inputs* and *process*. However, two of the Comparison schools scored substantially better—Comparison School 3 (scoring 4 on *inputs* and close to 3 on *process*) and Comparison School 1 (scoring 3 on *inputs* and about 4 on *process*). The last Comparison school (Comparison School 4) was between these two extremes.

The principal component based on the *inputs* and *process* scores was used in a secondary analysis. This analysis tested the interaction of time and this variable, which we will call the *Environmental Model Inputs and Process score*. This analysis found two significant interactions, both favoring schools with higher levels of this variable (indicated by the negative sign of the coefficient). The first is *Interpersonal Consequences due to Others' Drinking* (p=.04). This variable was an index based on the following experiences resulting from drinking by other students (see Rhodes, 2009): being pushed, hit or assaulted; being threatened with physical violence; having been in a physical fight; being in a verbal argument; being taken advantage of sexually; being a victim of sexual assault/rape; being harassed due to sexual orientation, race/ethnicity, religion, or gender; having personal property or residence damaged; and being a victim of another crime.

The second significant interaction is *Caused Alcohol-related Injuries to Others* (p<.01). This variable reflected students requiring medical treatment from injuries caused to others from automobile, motorcycle, bicycle, or all-terrain vehicle accidents; pedestrian accident; fall from height; sexual assault injuries; non-sexual assault injuries; stab wound, gunshot wound, burn, or other serious injury.

Discussion

SPARC was designed to test a comprehensive intervention using a community organizing approach to implement environmental strategies in and around college campuses. The ultimate goal was to reduce high-risk drinking and alcohol-related consequences among college students.

Analysis of data from student self reports (the CDS) found significant effects on two indicators of alcohol-related problems. Specifically, we found decreases in the Intervention group compared to the Comparison group in *Severe Consequences due to the Students' Own Drinking* and *Alcohol-related Injuries Caused to Others*.

We were interested in the substantive significance of these effects. Consequently, we estimated the population-level impacts of the observed effects. Based on the mean population enrollment size at the Intervention and Comparison schools (mean size I-schools=11,069.5, mean size C-schools=12,433.4), we estimated that by Year 4, the observed decrease in the proportion of students experiencing one or more severe consequence due to their own drinking in the past 30 days translates into an average of 228 fewer students in each Intervention school experiencing these consequences, compared to the Comparison schools. Similarly, students causing alcohol-related injuries to others that required medical treatment in the 12 months preceding the survey was reduced by an estimated 107 students in each Intervention school, compared to the Comparison schools. The magnitude of these estimates reflects the dictum that relatively small changes at the population level can translate into significant improvements in public health (Rose, 1993).

It is worth noting that we observed intervention effects on consequences of drinking (including both directly experienced and "second hand" consequences), but not on drinking behavior itself. There are at least two potential explanations for this pattern of findings. First, because of measurement error, social desirability, and choice of items to include in the survey, the drinking measures we used may not have been sensitive enough to detect changes in drinking behavior. Second, the intervention itself may have had more of an effect on alcohol-related consequences than on drinking frequency and quantity. One of the four categories of strategies coalitions could pursue was harm reduction. Moreover, a stronger policy and enforcement environment may have led students to be more cautious in their drinking behavior, with respect to drinking situations and high risk practices, even while maintaining pre-existing levels of frequency and quantity.

Cross-site variability in program implementation is a recurring issue in community-based intervention trials, such as SPARC. Reflecting the need to measure "dose" of the intervention at the site level, as well as the occurrence of intervention-type activities in Comparison schools, we constructed a measure of site level dose and incorporated it into secondary analyses. We found that this dose measure was associated with reductions in *Interpersonal consequences due to Others' Drinking* and *Alcohol-related Injuries Caused to Others*. The existence of a "dose-response" relationship may be considered additional evidence of a possible causal relationship between the SPARC intervention and the observed positive outcomes.

The SPARC study had a number of limitations. It used a repeated cross-sectional design, so conclusions about changes in individual behavior are not supported. It relied heavily on self report, although data from other data sources (a resident advisor survey and incident and injury reports) provide some confirmatory evidence of intervention effects (reported elsewhere). While response rates for the CDS were modest, there was very little evidence of response bias (females were slightly overrepresented), and there was no evidence of differences in response bias between students in the Intervention and Comparison

conditions. We deliberately recruited schools that were in the mid-range of readiness to undertake an intervention involving an environmental approach; it is likely that implementation of the intervention would have been less intense, and taken longer, in schools that were not as ready to engage in a SPARC-type approach. Finally, the study was limited to universities in a single state.

Despite these limitations, SPARC demonstrates the potential usefulness and efficacy of the application of a community organizing approach to implement environmental strategies in the college setting. It adds to a growing number of studies that provide evidence that an environmental approach, if implemented with commitment and intensity, can reduce rates of problems associated with high-risk drinking on college campuses (Weitzman et al., 2004; Nelson et al., 2005; Clapp et al., 2005; Saltz et al., 2009, 2010; Wood et al., 2009). An important next step is to identify effective means of disseminating such approaches to institutions of higher learning across the nation.

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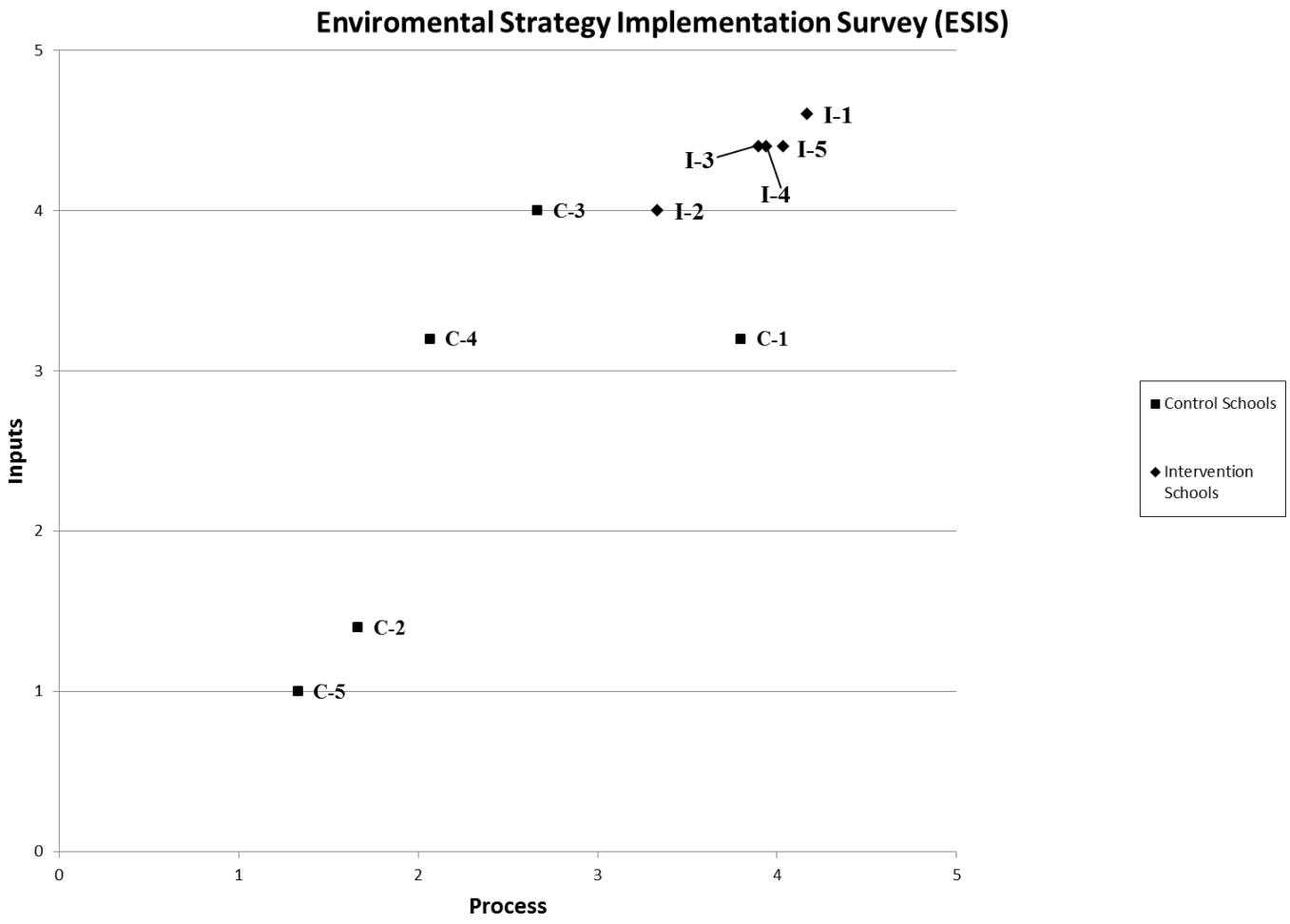

Figure 1.

Table 1

Environmental Strategies in Strategic Plans of SPARC Intervention Schools

SPARC Measure Strategy	# of schools using Strategy	School 1	School 2	School 3	School 4	School 5
Availability						
Restrict provision of alcohol to underage or intoxicated students	5	AEP	A E	AEP	AEP	A E
Increase/improve coordination between campus & community police	5	AEP	A E	AEP	AEP	A P
Restrict alcohol purchases, possession	4	AE		AEP	AEP	AEP
Restrict alcohol use at campus events	3		AEP	A	AEP	
Increase responsible beverage service policies & practices	2	AE			A	
Conduct compliance checks	2	AE			AEP	
Educate landlords about their responsibilities and liabilities	2			A P		A P
Price/Marketing						
Limit amount, type & placement of pro-drinking messages seen on campus	2	A P		AEP		
Social Norms						
Establish consistent disciplinary actions associated with policy violations	5	AEP	A	AE	AEP	AE
Create campaign to correct misperceptions about alcohol use	4	A	A	A		A
Enhance awareness of personal liability	4		A	AE	A	AE
Provide notifications to new students, parents of alcohol policies, penalties	4	AEP	AE	A	A	
Provide alternative late night programs	2		A P		A P	
Provide alcohol-free activities	2	A P			A P	
Provide parental notification of student alcohol violations	1			A		
Create policy to provide brief motivational module for all freshmen	1				A P	
Harm Minimization						
Enact party monitoring program	3		AEP	AE		AE
Create and utilize safe ride program	2			A P		A P
Increase harm reduction presence at large-scale campus events	1				AEP	

A= Awareness, E= Enforcement, P=Policy

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Table 2

Baseline Comparability of Students in the Intervention and Control Schools (2003 College Drinking Survey)

	Intervention Group (N = 1,977)		**Control Group (N = 1,834)**		**P-value[1]**
Academic Classification (Year in School)	Percentage	(SE)	Percentage	(SE)	0.70
Freshman	56.4%	(8.7)	56.1%	(7.7)	
Sophomore	19.7%	(4.5)	18.2%	(6.5)	
Junior	12.9%	(2.3)	14.1%	(2.7)	
Senior	11.2%	(4.2)	11.3%	(1.4)	
Gender					0.43
Male	39.2%	(7.7)	34.3%	(2.6)	
Female	60.8%	(7.7)	65.7%	(2.6)	
Race/Ethnicity					0.53
White	75.7%	(14.5)	82.9%	(6.8)	
African-American	9.1%	(7.4)	7.4%	(5.0)	
Hispanic	4.2%	(1.8)	3.5%	(0.6)	
Asian/PI	5.0%	(6.0)	3.0%	(1.7)	
Other	6.0%	(5.1)	3.3%	(0.5)	
Past 30 days Alcohol Use, any	65.3%	(7.4)	66.6%	(4.3)	0.56
Binge drink, past 30 day[2]	45.1%	(8.0)	48.8%	(6.4)	0.31
Gets drunk at least once in typical week	34.5%	(8.6)	37.3%	(6.9)	0.39

[1] P-value is from comparison of intervention vs. control schools for significant differences, adjusted for within-school clustering.

[2] Binge drinking is defined as 5 drinks in a row for males, 4 drinks in a row for females, at least once in past 30 days

Table 3

Impact of SPARC on High-risk Drinking, Alcohol-related Consequences, and Alcohol-related Injuries: Results from 2003–2006 CDS[1]

	Internal Consistency[2]	Least-Squares Means (SE)								Random coefficient model Results	
		2003 (Baseline)		2004		2005		2006			
		I	C	I	C	I	C	I	C	Estimate (SE)	p-value
Drinking											
Past 30 day use (# days)	N/A	4.11 (.34)	4.73 (.34)	4.18 (.38)	4.81 (.38)	4.25 (.31)	4.88 (.31)	4.33 (.39)	4.96 (.39)	−0.01 (.16)	0.98
Binge Drinking (# days in past 30 consumed 5 [for males] or 4 [for females] drinks in a row)	N/A	2.35 (.24)	2.73 (.24)	2.37 (.26)	2.73 (.26)	2.39 (.24)	2.73 (.24)	2.41 (.27)	2.73 (.27)	0.02 (.10)	0.83
Drunk (# days/ typical week)	N/A	0.55 (.06)	0.66 (.06)	0.57 (.07)	0.66 (.07)	0.58 (.06)	0.66 (.06)	0.60 (.07)	0.65 (.07)	0.02 (.02)	0.25
Most # drinks (past 30 days)	N/A	4.39 (.27)	4.84 (.27)	4.40 (.28)	4.76 (.28)	4.40 (.28)	4.67 (.28)	4.40 (.26)	4.58 (.26)	0.09 (.08)	0.27
Consequences											
Moderate Consequences, due to own drinking (Tier I)	$\alpha = 0.86$	7.78 (.60)	8.72 (.60)	8.05 (.64)	8.87 (.65)	8.33 (.56)	9.03 (.56)	8.60 (.65)	9.19 (.65)	0.12 (.26)	0.65
Severe Consequences, due to own drinking (Tier II) (%1+)	$\alpha = 0.79$	0.18 (.01)	0.18 (.01)	0.17 (.02)	0.18 (.02)	0.17 (.01)	0.18 (.01)	0.16 (.02)	0.18 (.02)	−0.01 (.003)	0.02
Interpersonal Consequences, due to others' drinking	$\alpha = 0.81$	1.34 (.12)	1.08 (.12)	1.23 (.13)	1.13 (.13)	1.18 (.11)	1.18 (.12)	1.11 (.13)	1.22 (.13)	−0.12 (.08)	0.16
Community Consequences, due to others' drinking	$\alpha = 0.75$	5.38 (.38)	4.49 (.38)	5.14 (.39)	4.38 (.39)	4.90 (.38)	4.26 (.38)	4.66 (.39)	4.15 (.39)	−0.13 (.16)	0.41
Alcohol-related Injuries											
Experienced (%1 +)	$\alpha_{KR-20} = 0.93$	0.12 (.01)	0.14 (.01)	0.11 (.01)	0.13 (.01)	0.12 (.01)	0.11 (.01)	0.11 (.01)	0.11 (.01)	0.01 (.004)	0.15
Caused to Others (%1+)	$\alpha_{KR-20} = 0.98$	0.04 (.003)	0.04 (.003)	0.03 (.004)	0.03 (.004)	0.02 (.003)	0.03 (.003)	0.02 (.004)	0.03 (.004)	−0.01 (.001)	0.03

[1] Adjusted linear or logistic random coefficient mixed-effects models for CDS data, adjusted for within-school clustering, gender, race, and academic classification. Numbers given are the estimated least-squares means (population margins) or predicted probabilities; (standard error). Estimate (SE) and p-values in last column are from Type III test of condition x time interaction (I vs. C), where the null hypothesis is that there is no difference in the change of the outcome over time between I and C schools; A negative estimate indicates a declining trend over time in I schools compared to C schools.

[2] Internal consistency measures are Cronbach's alpha (α) or KR-20 (α_{KR-20}), alpha for dichotomous items; N/A = internal consistency measures not available for a single survey item.

Table 4

Impact of SPARC on High-risk Drinking, Alcohol-related Consequences, and Alcohol-related Injuries: Results from 2003–2006 CDS: Time x ESIS measures[1]

	Least-Squares Means (SE)								Random coefficient model Results	
	2003 (Baseline)		2004		2005		2006			
	I	C	I	C	I	C	I	C	Estimate p-value (SE)	
Drinking										
Past 30 day use (# days)	4.16 (.24)	4.68 (.24)	4.17 (.23)	4.82 (.23)	4.19 (.22)	4.96 (.22)	4.20 (.27)	5.10 (.26)	−0.06 (.06)	0.28
Binge Drinking (# days in past 30 consumed 5 [for males] or 4 [for females] drinks in a row)	2.40 (.21)	2.69 (.21)	2.38 (.20)	2.73 (.20)	2.35 (.20)	2.77 (.19)	2.33 (.22)	2.81 (.21)	−0.03 (.04)	0.39
Drunk (# days/ typical week)	0.55 (.06)	0.66 (.06)	0.56 (.06)	0.67 (.05)	0.57 (.05)	0.67 (.05)	0.58 (.06)	0.67 (.06)	0.004 (.01)	0.58
Most # drinks (past 30 days)	4.43 (.29)	4.79 (.29)	4.40 (.26)	4.74 (.26)	4.37 (.24)	4.69 (.23)	4.33 (.23)	4.64 (.22)	0.008 (.03)	0.82
Consequences										
Moderate Consequences, due to own drinking (Tier I)	8.09 (.54)	8.42 (.53)	8.21 (.52)	8.72 (.51)	8.34 (.50)	9.03 (.49)	8.47 (.58)	9.33 (.57)	−0.09 (.11)	0.42
Severe Consequences, due to own drinking (Tier II) (%1+)	0.18 (.01)	0.20 (.01)	0.17 (.01)	0.20 (.01)	0.17 (.01)	0.19 (.01)	0.16 (.01)	0.19 (.01)	0.001 (.001)	0.49
Interpersonal Consequences, due to others' drinking	1.32 (.14)	1.11 (.14)	1.24 (.11)	1.15 (.11)	1.17 (.10)	1.19 (.10)	1.09 (.12)	1.23 (.12)	−0.06 (.03)	0.04
Community Consequences, due to others' drinking	5.06 (.43)	4.82 (.42)	4.87 (.38)	4.66 (.38)	4.67 (.36)	4.50 (.35)	4.48 (.36)	4.34 (.35)	−0.02 (.06)	0.79
Alcohol-related Injuries										
Experienced (%1 +)	0.12 (.007)	0.13 (.007)	0.12 (.007)	0.12 (.007)	0.11 (.007)	0.12 (.007)	0.10 (.007)	0.11 (.007)	<0.001 (.002)	0.85
Caused to Others (%1+)	0.04 (.002)	0.03 (.003)	0.03 (.003)	0.03 (.003)	0.02 (.002)	0.03 (.003)	0.02 (.003)	0.03 (.003)	−0.01 (.001)	<0.01

[1]Adjusted linear or logistic Random coefficient mixed-effects models for CDS data, adjusted for within-school clustering, gender, race, and academic classification. Numbers given are the estimated least-squares means (population margins) or predicted probabilities; (standard error).

[*]Estimate (SE) and p-values in last column are from interactions of ESIS measure and time, where the null hypothesis is that the effect of the intervention does not depend upon the implementation levels of the ESIS measure; A negative estimate indicates a declining trend in I schools compared to C schools for higher levels of implementation.