Internet-Based Personalized Feedback to Reduce 21st-Birthday Drinking: A Randomized Controlled Trial of an Event-Specific Prevention Intervention

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Abstract

This article presents an initial randomized controlled trial of an event-specific prevention intervention. Participants included 295 college students (41.69% male, 58.31% female) who intended to consume 2 or more drinks on their 21st birthday. Participants completed a screening/baseline assessment approximately 1 week before they turned 21 and were randomly assigned to receive Web-based personalized feedback or assessment only. Feedback included normative information, protective behaviors, and personalized blood alcohol concentration information. A follow-up assessment was completed approximately 1 week after a student's birthday. Results indicated a significant intervention effect in reducing estimated blood alcohol concentration ($d = 0.33$). The intervention effect was moderated by 21st-birthday drinking intentions, and the intervention was primarily effective among those who intended to reach higher levels of intoxication. Results provide some support for normative information as a mediator of intervention efficacy. Overall results provide support for Web-based personalized feedback as an intervention approach for specific events associated with extreme drinking.

Keywords

alcohol; social norms; Web; celebration

This article describes the empirical evaluation of one example of a new prevention paradigm for college student drinking: event-specific prevention (ESP; Neighbors et al., 2007). Much progress has been made in individually focused alcohol prevention strategies for college populations (Larimer & Cronce, 2002, 2007). Although documentation of effective strategies has been encouraging, the relatively global level of focus of such strategies (e.g., reducing average drinking levels or average number of drinks per week over some specified period of time) fails to take advantage of our knowledge regarding the severity and timing of specific events in which drinking is particularly extreme (e.g., 21st-birthday celebrations, spring break, holidays, specific sporting events; Neighbors et al., 2007). This article describes the evaluation of a Web-based personalized ESP intervention targeting 21st-birthday drinking. Personalized feedback has consistently been found effective in reducing college student drinking assessed at a general level of specificity (Carey, Scott-Sheldon, Carey, & DeMartini, 2007; Larimer & Cronce, 2002, 2007; Walters & Neighbors, 2005), but, to our knowledge, this intervention is the first systematic adaptation of this approach to have targeted a single high-risk event.

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21st-Birthday Drinking

With respect to specific events associated with extreme drinking, 21st-birthday celebrations have begun to receive widespread attention in the media and among college administrators. In the United States, turning 21 represents a transition to legal drinking age, and celebrations involving alcohol are, for many, a rite of passage. Traditions have evolved in which individuals celebrating their 21st birthday are encouraged by their peers to drink extreme and potentially dangerous amounts of alcohol. These traditions include consuming as many liquor shots as possible (often 21 shots) during "power hour" (midnight to 1:00 a.m. on one's 21st birthday) and attempting the "21 for 21" (one shot for every year), also referred to as "the 21 run."

In response to a combination of deaths reported elsewhere, as well as a death and two hospitalizations in their community, Neighbors and colleagues (Neighbors, Oster-Aaland, Bergstrom, & Lewis, 2006; Neighbors, Spieker, Oster-Aaland, Lewis, & Bergstrom, 2005) initiated an empirical investigation to evaluate the prevalence of 21st-birthday drinking. Results of those investigations revealed that of students celebrating their 21st birthdays, 90% reported consuming alcohol as part of their celebration, 75% went to a bar, 61% reached a blood alcohol content (BAC) above the legal driving limit, and 23% reached a BAC above .25. Results also showed that perceived norms for 21st-birthday drinking were associated with drinking during this specific event.

Smith, Bogle, Talbott, Gant, and Castillo (2006) found that students drank an average of 3.81 drinks more on their 21st birthday ($M = 6.49$, $SD = 7.69$) than on their typical drinking day and 1.73 standard drinks more than on their peak drinking day ($M = 4.76$, $SD = 5.60$) in the month prior to their 21st birthday. Most recently, Rutledge, Park, and Sher (2008) evaluated 21st-birthday drinking among over 2,000 students and found that 83% reported drinking to celebrate their birthday, 12% reported consuming 21 drinks on this occasion, and over half had exceeded their previous maximum quantity consumed on a single occasion. In sum, these findings demonstrate that 21st birthdays are commonly associated with the consumption of extreme and dangerous levels of alcohol, and effective prevention efforts targeting this specific event are needed.

Previous Prevention Efforts Targeting 21st-Birthday Celebrations

Although there have been a handful of 21st-birthday preventative interventions, all have fallen short of identifying an efficacious intervention that is associated with reducing 21st-birthday alcohol consumption in a randomized controlled design and an intent-to-treat analysis approach (Hembroff, Atkin, Martell, McCue, & Greenamyer, 2007; Lewis, Neighbors, Lee, & Oster-Aaland, 2008; Neighbors et al., 2005; Neighbors, Oster-Aaland, et al., 2006; Smith et al., 2006). These studies evaluated interventions that consisted of mailed birthday cards, most of which comprised a single-intervention component, such as normative information (Lewis et al., 2008; Smith et al., 2006).

For example, Lewis et al. (2008) evaluated a birthday card that creatively presented personalized normative feedback comparing the number of drinks students intended to consume on their 21st birthday and their perceptions of the typical number of drinks consumed by 21st-birthday celebrants with actual 21st-birthday norms. Findings from this study indicated that, relative to control participants, those who received the card reported more accurate 21st-birthday norms. In addition, though there was no direct effect of the card on 21st-birthday drinking, those who had more accurate norms reported less drinking. Thus, Lewis et al. suggested that personalized normative feedback might be a worthwhile intervention component. In summary, results from these studies suggest that there is a need for a more comprehensive intervention approach that consists of more than a mailed birthday card.

Although there have not been efficacious interventions for reducing 21st-birthday drinking, there are efficacious generalized interventions for reducing college student drinking.

Generalized Personalized Feedback Interventions

Personalized feedback interventions are individually focused interventions. At minimum, they involve the assessment and feedback of personal drinking behavior, and they often include feedback regarding drinking norms, drinking consequences, expectancies, BAC information, and protective behaviors (Walters & Neighbors, 2005). Personalized feedback interventions have been successfully delivered in the college student population in person (Borsari & Carey, 2000; Dimeff, Baer, Kivlahan, & Marlatt, 1999; Larimer et al., 2001; Marlatt et al., 1998), by mail (Agostinelli, Brown, & Miller, 1995; Collins, Carey, & Sliwinski, 2002; Larimer et al., 2007), and by computer (Lewis & Neighbors, 2007; Lewis, Neighbors, Oster-Aaland, Kirkeby, & Larimer, 2007; Neighbors, Larimer, & Lewis, 2004; Neighbors, Lewis, Bergstrom, & Larimer, 2006). The personalized feedback evaluated in the present study included components similar to those that have been used in previous research, but the components were tailored to target the 21st birthday specifically. For example, perceived and actual norms were specific to 21st-birthday alcohol consumption. Similarly, estimated BAC and potential effects of BAC were based specifically on the amount of alcohol and period of time that participants reported an intention to drink on their 21st birthday. Moreover, although personalized feedback for heavy drinking college students delivered by computer has been found efficacious (Lewis & Neighbors, 2007; Lewis et al., 2007; Neighbors, Lewis, et al., 2006; Neighbors, Palmer, & Larimer, 2004), few studies have evaluated Web-delivered personalized feedback that does not require on-site participation (Walters, Vader, & Harris, 2007).

Mediators of Intervention Efficacy

Existing literature has repeatedly shown that students overestimate how much their peers drink in general (see Borsari & Carey, 2003, for meta-analysis) and for specific events, such as 21st birthdays (Lewis et al., 2008; Neighbors, Oster-Aaland, et al., 2006). Previous research has been relatively consistent in finding that effective reduction of these normative misperceptions is associated with reduced drinking (Borsari & Carey, 2000; Lewis & Neighbors, 2007; Neighbors, Lewis, et al., 2006; Neighbors, Larimer, & Lewis, 2004) and is potentially promising for reducing 21st-birthday drinking more specifically (Lewis et al., 2008). Thus, we expected that providing students with personalized normative feedback regarding 21st-birthday drinking would mediate intervention efficacy.

We were also interested in evaluating the use of protective behaviors as a mediator of intervention efficacy. Emerging evidence has revealed that protective behaviors (e.g., limiting the number of drinks, avoiding drinking games, knowing where one's drink has been at all times, avoiding drinks that contain multiple shots) are associated with less extreme drinking (Haines, Barker, & Rice, 2006; Martens, Pedersen, LaBrie, Ferrier, & Cimini, 2007; Walters, Roudsari, Vader, & Harris, 2007). In a recent study, Larimer et al. (2007) found that the efficacy of a mailed personalized feedback intervention, which included protective behaviors, was mediated by increased use of protective behaviors. We expected that, as has been found with typical drinking behavior, use of protective behaviors by those celebrating turning 21 would be associated with consuming less alcohol and reaching lower BACs. Thus, we expected that providing students with information regarding protective behaviors would mediate intervention efficacy.

Moderators of Intervention Efficacy

We were also interested in evaluating whether personalized feedback for 21st-birthday drinking might vary as a function of typical drinking patterns and students' drinking intentions for 21st

birthdays. Some evidence suggests that personalized feedback may be more effective with heavier drinking students (Murphy et al., 2001). This could be particularly true for event-specific personalized feedback, which may be less relevant for students who do not intend to drink heavily. Moreover, feedback designed to reduce extreme drinking may have limited relevance for students who have no intentions to drink heavily in the first place. Thus, we expected the intervention to be more effective among students who were heavier drinkers in general and, more specifically, among those who intended to drink more heavily on their 21st birthdays.

The Present Study

The present study provides a first test of ESP and adds an important contribution in evaluating a potentially promising delivery method that has as yet remained largely untested in this population. Web-based interventions have extremely high potential, because they can be disseminated easily and are relatively inexpensive in comparison with interventions that require on-site participation. In addition, Web delivery can greatly improve the precision of intervention timing; this improvement may be critical to the feasibility of intervening immediately prior to a known specific event associated with extreme drinking. We also aimed to evaluate social norms and protective behaviors as mediators of intervention efficacy and to evaluate typical drinking and 21st-birthday drinking intentions as moderators of intervention efficacy.

Method

Participants

Participant flow through the study is presented in Figure 1. Participants for the present study included 295 students (41.69% men and 58.31% women) who turned 21 during two academic quarters at a large public northwestern university and who reported intending to consume two or more drinks on their 21st birthday. The screening criterion of intent to drink two or more drinks was selected with the aim of including as many students as possible who might benefit from the intervention. Thus, although we were not interested in intervening with students who had no intentions to drink, neither did we want to exclude students who might end up drinking more than they intended.

The ethnic composition of participants in the study was similar to the makeup of the total invited sample of 831 students. The composition of the 295 recruited participants was 2.3% African American, 24.3% Asian, 60.9% White, 1.3% Native American, 0.3% Pacific Islander, and 11.0% other. The composition of the larger invited sample, based on the registrar's data, was 2.9% African American, 24.5% Asian, 58.5% White, 1.6% Native American, 0.5% Pacific Islander, and 12.0% other. There was no significant difference in ethnic composition based on whether or not students decided to participate, $\chi^2(5, N = 831) = 1.69$. In regard to gender, our sample included 58.1% women and 41.9% men, whereas the invited sample included 54.5% women and 45.5% men. Women were not more likely to participate than were men, $\chi^2(1, N = 831) = 0.99$, $p = ns$. Baseline drinking of the students who completed the screen was comparable with the typical drinking in other samples on the same campus. In particular, among students who completed the screen for the present study, the average number of drinks per week in the screening sample ($M = 6.46$, $SD = 9.88$) did not differ significantly from the baseline weekly drinking of 21-year-olds in a recent universal prevention study (Larimer et al., 2007) conducted on the same campus ($M = 6.08$, $SD = 7.30$), $t(624) < 1$. Incentives for participation were $10 for completing the screening survey, $20 for completing the baseline assessment, and $15 for completing the follow-up assessment.

Procedures

A list of all students who would turn 21 from fall quarter 2006 through spring quarter 2007 was obtained from the university registrar. Initial invitations to participate were sent to all students on the list by e-mail and U.S. mail 1 week prior to their 21st birthday. The letter and e-mail included a general description of the project and invited the students to log on to the study website for further information or to participate in the study. The introductory e-mail was immediately followed by a separate e-mail that included a link with an embedded personal identification number enabling participants to log on to a secure website that included consent information and the online assessment. This first survey served as a screening survey. Our purpose in the present study was to evaluate the efficacy of an intervention to reduce drinking on 21st birthdays; thus, students were screened for intention to consume alcohol (at least two drinks) on their 21st birthday.

Recruitment was completed on a rolling basis and with the goal of recruiting 300 participants who intended to drink two or more drinks as they celebrated their 21st birthday. Power analyses conducted prior to recruitment indicated that with a sample of 300 participants, the study would have .70 and .98 power to detect effects in the small-to-medium range (i.e., .25 and .40, respectively). Invitations to complete screening were sent to 831 students. Of these, 399 students (48.01%) completed screening. Students who met screening criteria ($N = 295$, 73.93%) were seamlessly routed to the baseline survey. Upon completion of baseline, participants were randomized to receive Web-based personalized feedback or to be in an assessment-only control group.

Two days before their birthday (and again the day before), students who were randomized to intervention received an e-mail with a link to the Web-based personalized feedback. Four days after their 21st birthday, students were asked to complete an online postsurvey assessing their drinking-related behaviors during the week of their 21st birthday. Students randomized to the control group did not receive any information or e-mails prior to the birthday and were contacted 4 days after their birthday for the online postsurvey. Of the 295 participants who completed baseline, 282 (95.59%) also completed follow-up.

Randomization—Randomization was completed with an urn procedure (Stout, Wirtz, Carbonari, & Del Boca, 1994) whereby students were randomized with an electronic randomization algorithm. Participants were randomly assigned to intervention or control in four groups on the basis of the maximum number of drinks they intended to consume while celebrating their 21st birthday (<6, 6-10, 11-15, and >15). We used urn randomization to help ensure baseline equivalence between groups. To ensure equivalence among students with lighter and heavier drinking intentions for their 21st birthday, we used four drinking levels that were based on data from a previous 21st-birthday study (Lewis et al., 2008).

Intervention—Students were randomized to 21st-birthday-specific personalized feedback or to an assessment only control group. Students randomized to the intervention condition received Web-based personalized feedback 2 days before their 21st birthday. Participants received an e-mail 2 days before their 21st birthday (and again the day before) with a link to a birthday card with a humorous message about moderation on 21st birthdays. On the screen following the birthday card, students were given personalized feedback about their drinking intentions and expectations for their upcoming 21st birthday that was based on information given in the screening survey. Participants assigned to this condition were able to view the feedback online and could print the feedback if their computer was attached to a printer.

The brief personalized feedback was adapted from the feedback utilized in the Brief Alcohol Screening and Intervention for College Students (BASICS; Dimeff et al., 1999; Marlatt et al., 1998; see Larimer & Cronce, 2002, 2007, for reviews) as well as from recent work on

computerized normative feedback for alcohol prevention (Lewis & Neighbors, 2007; Lewis et al., 2007; Neighbors, Oster-Aaland, et al., 2006; Neighbors, Larimer, & Lewis, 2004). Specific emphasis was placed on drinking intentions, BAC information, normative information, and protective behavior strategies. The feedback consisted of nine pages and is available online as supplementary material to this article. The introduction included a harm reduction message noting that the intention was not to convince students not to drink on their birthday but rather to provide information that would enable them to have a safe, fun, and memorable 21st birthday. Participants were presented with feedback about their intended number of drinks on their 21st birthday, resulting intended BAC, and effects of alcohol at varying BACs. Participants were also provided a printable personalized BAC chart based on their gender and weight. In addition, participants received graphic feedback regarding perceived and actual descriptive norms (in this case 6.80 drinks) for drinking on 21st birthdays; these norms were based on prior work that evaluated 21st-birthday norms and drinking (Lewis et al., 2008; Neighbors, Oster-Aaland, et al., 2006) and modeled after previous implementations of personalized normative feedback interventions (e.g., see Neighbors, Larimer, & Lewis, 2004; see Appendix).

Participants were provided a list of protective behavior strategies designed to encourage and aid in moderation (e.g., setting a limit, spacing drinks, alternating alcoholic and nonalcoholic drinks). Additional content related to expected effects and consequences was included. On the final page of the feedback there was a link to print the feedback and the statement "You are almost finished! Please click Next." The "Next" button was a link to a brief satisfaction survey, which we included to evaluate treatment integrity by providing verification that feedback had been viewed in its entirety and to assess participants' thoughts about the feedback.

Measures

Measures included in the present analyses focused on evaluating intervention efficacy, perceived norms and protective behaviors as mediators, and 21st-birthday drinking intentions (i.e., number of drinks and BAC) and typical weekly drinking as moderators. Typical weekly drinking, 21st-birthday drinking intentions, perceived norms, and protective behavior intentions were all assessed at baseline. Perceived 21st-birthday drinking norms and protective behaviors were also assessed at follow-up, along with actual 21st-birthday drinking.

21st-birthday drinking intentions—We used a modified Daily Drinking Questionnaire (DDQ; Collins, Parks, & Marlatt, 1985; Dimeff et al., 1999) to ask participants to report the number of drinks they intended to consume on each day of the week of their 21st birthday (3 days before to 3 days after). They were also asked to report the period of time in which they intended to drink for each of the 7 days. Intended number of drinks was assessed by the number of standard drinks participants reported intending to consume on their 21st birthday. Intended BAC was estimated from a widely used modification of the Widmark formula (National Highway Traffic Safety Administration, 1994). This formula has been shown to estimate BAC with relatively good accuracy and is comparable to other estimation formulas (Carey & Hustad, 2002; Hustad & Carey, 2005). The formula takes into account the amount of alcohol consumed, average metabolism rate, weight, and gender differences in percentage of body weight attributed to water. BAC is expressed in terms of grams of ethanol per 100 ml of blood (percentage g/ml). Metabolism rate can vary as a function of multiple factors, and we used the average rate, subtracting .017 per hour over which alcohol was consumed with maximum reduction set at zero BAC. In extreme cases in which individuals report drinking large amounts of alcohol in short periods of time, estimates can exceed lethal levels. In the present study, estimated BACs Windsorized with values above .5 were recoded to .5. This recoding affected 3 participants' scores on 21st-birthday intended BAC. Intentions were assessed as a potential moderator of intervention efficacy.

We used a modified version of the DDQ (Collins et al., 1985; Dimeff et al., 1999) to assess 21st-birthday drinking. However, rather than ask students to report their drinking during a typical week in the previous 3 months, we asked them to report their actual drinking during the week of their 21st birthday as well as the duration of consumption on each of those 7 days (3 days before to 3 days after their birthday). Number of drinks on 21st birthday was scored as the number of standard drinks that participants reported consuming on their 21st birthday. BAC on 21st birthday was the primary outcome measure and was calculated with the above described version of the Widmark formula (National Highway Traffic Safety Administration, 1994). As with intentions, estimated BACs above .5 were recoded to .5. This recoding affected 3 participants' scores.

We assessed 21st-birthday perceived norms to estimate the average number of drinks consumed by the typical student at the university on his or her 21st birthday at baseline and at follow-up. In particular, participants were asked, "How many drinks on average do you think a typical [university name] student consumes on his or her 21st birthday?" Response options ranged from 0 (*0 drinks*) to 25 (*25 or more drinks*). Perceived norms were assessed as a potential mediator of intervention efficacy and were assessed at baseline and follow-up.

We used a modification of the Protective Behavioral Strategies Scale (Martens et al., 2005, 2007) to assess 21st-birthday protective behaviors intentions at baseline. This scale assesses participants' engagement in 15 specific behaviors associated with less extreme drinking (e.g., put extra ice in your drinks, stop drinking at a predetermined time, alternate alcoholic and nonalcoholic drinks). Intentions were assessed by modifying instructions so participants were asked to indicate the likelihood that they would engage in each of the 15 behaviors while celebrating their 21st birthday. Response options ranged from 1 (*extremely unlikely*) to 7 (*extremely likely*). This measure was scored as the mean of the 15 items, and possible values ranged from 1 to 7 ($\alpha = .89$).

We assessed 21st-birthday protective behaviors at follow-up with a modification of the Protective Behavioral Strategies Scale (Martens et al., 2005, 2007). This measure included the same 15 items assessed for intentions, but participants were instructed to indicate whether they had engaged in each of the 15 behaviors when celebrating their 21st birthday (*yes* or *no*). This measure was scored as the number of strategies that participants used while celebrating their 21st birthday; possible scores ranged from 0 to 15 ($\alpha = .76$). Protective behaviors were assessed as a potential mediator of intervention efficacy.

Typical weekly drinking was assessed with the Daily Drinking Questionnaire (DDQ; Collins et al., 1985; Dimeff et al., 1999). Participants were asked to report the average number of standard drinks consumed and the time period of consumption for each day of the week over the previous 3 months. The score was calculated as the sum of standard drinks over the typical 7 days. For this measure, participants were instructed not to include 21st-birthday drinking in their estimates. Typical weekly drinking was examined as a moderator in the present analyses.

Satisfaction survey—Intervention participants were asked four questions regarding their perceptions of the feedback. Participants rated their level of agreement, from 1 (*strongly disagree*) to 7 (*strongly agree*), for each of the following statements: "I found the information provided interesting," "I am confident that the information provided is accurate," "I found the information provided surprising," and "I am likely to use the information provided to make decisions about my drinking while celebrating my 21st birthday."

Results

Correlations and Descriptive Information

Correlations among study variables are presented in Table 1. All correlations were significant and were in the expected directions. Correlations ranged in magnitude from small to moderate except that, unsurprisingly, number of drinks and BAC were strongly correlated for both intentions at baseline and actual drinking reported at follow-up. Consequently, BAC was evaluated as the primary outcome in the analyses presented below. Perceived norms were positively correlated with drinking intentions and drinking, whereas intended protective behaviors and actual protective behaviors were negatively correlated with drinking and intentions. Means and standard deviations for 21st-birthday drinking intentions, prebirthday perceived norms, follow-up drinking outcomes, and follow-up 21st-birthday perceived norms by condition are presented in Table 2.

Baseline Differences and Attrition

Intervention and control participants did not differ significantly at baseline in their typical weekly drinking, 21st-birthday perceived norms, intended number of drinks, or intended BAC. However, the intervention group did report greater 21st-birthday protective behaviors intentions, $t(293) = 2.10$, $p < .05$. Of the 295 participants who completed the baseline assessment, 283 (96%) completed the follow-up assessment. The attrition rate (6 in each group) did not differ between the intervention and control groups. Participants who did not complete the follow-up assessment did not differ from completers on baseline measures in their intended number of drinks, intended BAC, 21st-birthday perceived norms, or 21st-birthday protective behaviors intentions (all ts < 1).

Intervention Efficacy

Intervention efficacy was evaluated with hierarchical multiple regression (Cohen, Cohen, West, & Aiken, 2003) where BAC on 21st birthday was specified as the dependent variable. Analysis utilized an intent-to-treat approach (see *Treatment integrity* section below regarding exposure to feedback). Independent variables for the main effects model, which included typical weekly drinking, estimated BAC based on intentions to drink on one's 21st birthday, and intervention condition, were entered at Step 1. We also tested a moderation model to evaluate whether the intervention effect varied as a function of typical weekly drinking and estimated BAC intentions; the relevant two-way product terms were added at Step 2. Typical drinking and BAC intentions were mean centered to facilitate interpretation of interactions and tests of simple slopes with methods described by Cohen et al. (2003). Collinearity diagnostics revealed no problematic levels of tolerance or variance inflation. Cohen's *d* was calculated as a measure of effect size according to the formula

$$d = 2t / \sqrt{df}$$

(Rosenthal & Rosnow, 1991). Small, medium, and large effects are generally considered to be .2, .5, and .8, respectively (Cohen, 1992).

Regression results are presented in Table 3. Results at Step 1 revealed that, relative to the control group, the intervention group was associated with lower BACs ($d = 0.33$) reached on participant's 21st birthday and with an effect size in the small-to-medium range. Marginal means for estimated BAC on participants 21st birthday were .099 ($SE = .007$) for intervention participants in comparison to .126 ($SE = .007$) for control group participants. Typical weekly drinking was positively associated with BAC, and this indicated that students who were

generally heavier drinkers drank more on their 21st birthdays. BAC intentions were strongly associated with BACs reached on participants' 21st birthdays.

Results at Step 2 revealed no support for typical drinking as a moderator of intervention efficacy, whereas the interaction between intervention condition and BAC intentions was significant. The pattern of the interaction suggests that the intervention had a stronger effect on BACs among those who intended to reach higher BACs. Figure 2 presents simple slopes for the intervention effect at high and low values of BAC intentions. High and low values were specified as one standard deviation above and below the mean respectively, as is customary in graphing and interpreting interactions involving continuous variables (Aiken & West, 1991;Cohen et al., 2003). Tests of simple slopes further revealed that among participants who intended to drink less heavily on their 21st birthday, the intervention had no significant impact on 21st-birthday drinking, $\beta = -.02$, $t(275) = -.32$, $d = 0.04$. In contrast, among participants who reported higher BAC intentions, actual BACs reached on participants' 21st birthday were significantly lower in the intervention group than in the control group, $\beta = -.21$, $t(275) = -3.37$, $p < .001$, $d = 0.41$. Although the Aiken and West approach to graphing interactions has the advantage of providing point estimates, it is limited in its ability to communicate the distribution of the actual data. As an alternative approach, Figure 3 presents scatter plots of the actual data with BAC intentions on the *x*-axis and 21st-birthday BAC on the *y*-axis. Regression lines are presented separately for the control condition (left) and the intervention condition (right) and are adjusted for typical drinking.

Normative Perceptions and Protective Strategies as Mediators of Intervention Efficacy

We evaluated normative perceptions and protective behavior strategies as mediators of intervention efficacy with structural equation modeling using full information maximum likelihood estimation (Arbuckle & Wothke, 1999; Bollen, 1989). This approach was chosen on the basis of its ability to evaluate multiple mediators simultaneously (MacKinnon & Dwyer, 1993; MacKinnon, Fairchild, & Fritz, 2007) and its state-of-the-art treatment of missing responses (Shafer & Graham, 2002; Wothke, 2000). Model fit was evaluatd by several fit indices (Bollen & Long, 1993): the normed fit index (NFI), the Tucker-Lewis index, the comparative fit index (CFI), and the root-mean-square error of approximation (RMSEA). Values exceeding .90 and .95 indicate reasonable and good fit respectively on the NFI, TLI, and CFI. RMSEA values equal to or below .05 indicate excellent fit, values between .05 and .08 indicate reasonable fit, and values larger than .10 are indicative of a poor fit (Browne & Cudeck, 1993).

An initial direct effects model was fit evaluating 21st-birthday BAC as a function of intervention condition when controlling for intentions. The resulting model provided excellent fit to the data, $\chi^2(1, N = 295)$, $= .33$, *ns*, NFI = 0.99, TLI = 1.00, CFI = 1.00, RMSEA = 0.00, and replicated the results of the conventional analyses presented above. Moreover, the intervention condition was associated with significantly less 21st-birthday drinking than was the control condition ($z = -2.33$, $p = .02$, $d = 0.27$). This model was extended by a mediation model that included indirect effects of the intervention on 21st-birthday BAC (controlling for intentions) through perceived norms and protective strategies. Thus, direct paths were specified from intervention to follow-up perceived norms, controlling for baseline perceived norms, and from intervention to protective behavioral strategies used while celebrating one's 21st birthday, controlling for intentions to use protective strategies assessed at baseline. In turn, direct effects were specified from follow-up perceived norms to 21st-birthday BAC and from protective behavioral strategies used while celebrating one's 21st birthday to 21st-birthday BAC.

The mediation model with standardized parameter estimates is presented in Figure 4. For the sake of clarity, error terms are not included in the figure. The resulting model provided reasonable fit to the data, $\chi^2(24, N = 295) = 26.76$, $p < .01$, NFI = 0.95, TLI = 0.93, CFI = 0.97,

RMSEA = 0.07. Of greatest relevance, the intervention was associated with significantly lower perceived norms at follow-up, which were in turn significantly associated with 21st-birthday drinking. In contrast, the intervention was not significantly associated with increased use of protective behavior strategies by individuals celebrating their 21st birthday, although protective strategies were associated with 21st-birthday BAC. Mediation was formally evaluated by testing indirect effects using the ab products method as described by MacKinnon and colleagues (MacKinnon & Dwyer, 1993;MacKinnon et al., 2007), in which the standard error for indirect effects was estimated using the Sobel (1982) formula. Results indicated that the indirect path from intervention to drinking through changes in perceived norms was significant ($z = 4.09$, $p < .001$), whereas the indirect path through protective behaviors was not significant ($z = -0.45$). In sum, results supported changes in perceived norms, but not protective behavioral strategies, as a mechanism underlying intervention efficacy.

Thus, proposed mediators and the primary outcome were assessed concurrently. This does not provide an ideal test of mediation: Ideally, proposed mediators should be assessed prior to outcomes (Kazdin, 2007). Although this problem was not eradicated, we did fit an analogous model in which the concurrently measured mediators and outcome were reversed in the path model. On the basis of the model fit indices, the resulting model did not fit the data as well, $\chi^2(12, N = 53), = 52.99, p < .001$, NFI = 0.91, TLI = 0.83, CFI = 0.93, RMSEA = 0.12. Because this model and the proposed model are nonnested, there is no appropriate significance test with which to compare them directly. In lieu of a significance test, the average interitem correlation (AIC) is often used as a rule of thumb in comparing nonnested competing models involving the same variables, with fit preference attributed to the model that has the lowest AIC value. This criterion also provided support for the proposed mediation model (AIC = 74.76) versus the reverse mediation model (AIC = 98.99).

Treatment integrity—The standardization of the feedback ensured that the intervention material was provided to participants in a uniform format. However, one of the challenges presented by Web-based interventions is ensuring that participants view and attend to the feedback. In an attempt to assess the degree to which participants viewed and attended to the feedback, a link was provided at the end of the feedback to a brief satisfaction survey. Thus, logging onto the satisfaction survey provided evidence that participants had viewed all pages of the feedback. Results indicated that 118 of the 150 participants (79%) logged onto the satisfaction survey. Unfortunately, limitations in the programming of the feedback precluded us from directly assessing which pages participants viewed for how long or determining whether the 32 participants who did not log onto the satisfaction survey viewed some or all of the feedback.

Students who completed the satisfaction survey indicated relatively favorable reactions. Of the 118 students who logged onto the survey, 114 completed the satisfaction items. Ratings of agreement or strong agreement for each item respectively were as follows: "I found the information provided interesting" (89.47%); "I am confident that the information provided is accurate" (86.84%); "I found the information provided surprising" (63.16%); and "I am likely to use the information provided to make decisions about my drinking while celebrating my 21st birthday" (52.63%). In addition, regression analyses examining 21st-birthday drinking among intervention participants as a function of responses to satisfaction items, controlling for intentions, revealed that satisfaction items did not account for unique variance in drinking over and above intentions. The only exception to this was that participants who reported being more surprised by the feedback had lower estimated BACs on their birthdays, $t(93) = -2.32, p < .05$.

Discussion

This research evaluated the efficacy of a Web-based, personalized 21st-birthday intervention aimed at reducing BACs during 21st-birthday celebrations among college students. Findings revealed that the intervention was effective at reducing estimated BACs reached among students celebrating their 21st birthday. Effect sizes were relatively small, and though BAC decreased among intervention group participants, it was still on average over the legal limit of .08 at postintervention. The intervention was particularly effective in reducing estimated BACs reached for those students who had intentions to reach higher BACs. Finally, results provided some support for the reduction of normative perceptions of 21st-birthday peer drinking behavior as a mediator of intervention efficacy, although concurrent assessment of mediators and outcomes precludes strong conclusions. In contrast, no support was found for protective behavioral strategies as a mediator. This research offers significant contributions to the burgeoning literature on event-specific prevention and Web-based brief alcohol interventions.

As found with personalized interventions that focus on reducing typical drinking behavior (Carey et al., 2007; Larimer & Cronce, 2002, 2007; Walters & Neighbors, 2005), findings suggest that an event-specific personalized intervention can be effective at reducing heavy drinking among college students during that event. This is an important finding, because college student drinking is not stable but rather fluctuates on the basis of time of the week and school year and of holidays and events (Del Boca, Darkes, Green-baum, & Goldman, 2004; Greenbaum, Del Boca, Darkes, Wang, & Goldman, 2005) and because specific events, such as 21st birthdays, are associated with extreme alcohol consumption (Rutledge et al., 2008). The present findings suggest that intervention efforts can be focused during times or events in which we know college students tend to consume greater amounts of alcohol and thus are at highest risk for negative consequences. Of particular interest, the intervention was especially effective for those students who intended to reach higher BACs while they celebrated their birthday. Focusing prevention efforts for those at greatest risk and during times of greatest risk is likely to provide a good complement to prevention efforts aimed at behavior more generally, although future research is needed to directly evaluate this assertion. Additionally, future research should evaluate the extent to which event-specific prevention approaches may generalize to reducing typical drinking behavior in addition to reducing drinking relative to the targeted event.

The present study is also significant in that it is among the first empirically supported, entirely Web-based prevention interventions to have been found effective at reducing drinking behavior among college students (also see Walters, Vader, & Harris, 2007). Previous research on personalized feedback interventions has shown that interventions are effective by mail, in person, and by computer (Carey et al., 2007; Larimer & Cronce, 2007; Walters & Neighbors, 2005). However, previous computer-based interventions in this population have primarily been conducted in the laboratory (Lewis & Neighbors, 2007; Lewis et al., 2007; Neighbors, Lewis, et al., 2006; Neighbors, Larimer, & Lewis, 2004), rather than offsite via the Internet. This study is among the first to demonstrate the efficacy of a Web-based intervention to reduce college student drinking; it is also, to our knowledge, the first demonstration of an effective Web-based event-specific preventative intervention for 21st-birthday drinking behavior.

Consistent with findings related to brief personalized normative feedback interventions for typical drinking behavior (Lewis & Neighbors, 2007; Lewis et al., 2007; Neighbors, Lewis, et al., 2006; Neighbors, Larimer, & Lewis, 2004), reducing normative perceptions for peer 21st-birthday drinking behavior was associated with lower BACs in the intervention group than in the control group. One of the questions considered in the development of this intervention was whether presentation of 21st-birthday drinking norms might have iatrogenic effects. Moreover,

might it be harmful to tell students that the average student drinks 6.80 drinks on his or her 21st birthday? In this study, all participants intended to drink at least 2 drinks on their 21st birthday, and the average number of intended drinks reported was a little over 7. Results did not indicate evidence of an iatrogenic effect among those with lower drinking intentions, as indicated by the nonsignificant slope in the interaction between intervention and intentions. Nevertheless, careful consideration is warranted in the development of interventions in which norms are presented that suggest the average student consumes a significant number of drinks, particularly with respect to the perceived norms of the intended recipients (their norms should be higher than the actual norm) and with respect to their drinking intentions (ideally, their norms should be higher than the actual norm).

In contrast to the finding for perceived norms, no support was found for protective behaviors as a potential mediator of intervention efficacy. In the context of previous research suggesting the importance of protective strategies in more globally focused prevention interventions (Larimer et al., 2007), the null results in this study should be interpreted in light of methodological limitations in our operationalization of this construct. For instance, the specific protective behavioral strategies (intentions and behaviors) measured at both the pre- and post-assessment were not identical to the strategies presented in the personalized feedback. Furthermore, when assessing intentions to use protective behavioral strategies, we utilized an anchor scale, ranging from *extremely unlikely* to *extremely likely*. However, when assessing reported use of protective behavioral strategies, we used "yes" and "no" response options.

Although the current intervention did not reduce 21st-birthday drinking by increasing use of protective behavioral strategies, our findings do indicate that 21st-birthday-specific protective behavioral strategies were associated with 21st-birthday drinking. Students who had greater intentions to drink and who reported use of more protective behavioral strategies reached lower BACs on their 21st birthdays. Thus, though the intervention had no impact on protective behaviors in this study, protective behaviors were associated with lower intentions and drinking. In other research, protective behavioral strategies have been found to mediate personalized feedback interventions (Larimer et al., 2007) and, given the limitations in the present study, additional research exploring protective behavior strategies as an intervention component is encouraged.

Clinical Significance

Although this research demonstrated the efficacy of a Web-based personalized feedback intervention for 21st-birthday drinking, the effects were relatively small but comparable in magnitude to those of more general individual approaches to alcohol prevention among college students (for meta-analysis, see Carey et al., 2007). On the basis of the Carey et al. meta-analysis, we might expect larger effects if personalized feedback for 21st birthdays were presented in person rather than via the Web. Although Web-based interventions are more cost effective and less time consuming, there are possible benefits to implementing in-person interventions. For example, in-person interventions ensure that students receive feedback in hard copy form and that students go over each feedback component; they allow additional time to be spent on particularly relevant components and on coverage of additional topics or relevant topics that are not covered in the feedback. Treatment fidelity is also likely to be lower in Web-based interventions than in feedback that is provided in person, because there is no guarantee that recipients will carefully attend to the feedback and no easy way to monitor their level of attention. In the present study, only about 80% of intervention participants viewed the feedback in its entirety. It is difficult to know how closely even these participants attended to the feedback or whether additional procedures designed to increase attention to the feedback might result in stronger effects. Thus, adaptation of the Web-based personalized feedback to an in-person intervention may increase its effects and clinical significance.

Moreover, incorporating friends into either Web-based feedback or in-person feedback may increase the effects. Social factors that may be more relevant in explaining drinking at the situational level, such as 21st birthdays, include direct peer influence and modeling (Borsari & Carey, 2001; Marks, Graham, & Hansen, 1992). Direct peer influences, such as overt suggestions or offers to drink (e.g., being given an unsolicited drink by a friend), are associated with heavier and more problematic drinking (Wood, Read, Palfai, & Stevenson, 2001). Friends' influence on drinking is typically presented in personalized interventions (e.g., BASICS). However, existing interventions rarely incorporate the influence that friends have on drinking directly (e.g., recruiting friends to administer/support intervention efforts). The work of O'Leary Tevyaw (O'Leary Tevyaw, Bosari, Colby, & Monti, 2007; O'Leary et al., 2002) provides an exception and demonstrates both the feasibility and promise of incorporating friends in brief interventions. In sum, recruitment of friends who are interested and willing to help participants avoid experiencing alcohol-related problems during specific events is a strategy with potential promise to increase the effects of the Web-based intervention evaluated in the present study.

Finally, roughly half of the students who completed the satisfaction survey indicated that they would be likely to use the information provided to make decisions about their drinking while they celebrated their 21st birthday. Additional research should focus on which intervention components were useful or not useful to participants. Altering the intervention to include only those components that students indicated as useful may increase its effects.

Limitations/Future Directions

The strengths of the present study should be considered in the context of several notable limitations. The assessment-only control group raises the possibility that intervention effects might be a result of having received any feedback, additional attention, or multiple reminders; the salience of drinking; or a Hawthorne effect (Adair, 2000). In the future, researchers who examine ESP interventions might consider including attention control feedback in place of or in addition to assessment only.

An additional limitation of the present study is the low participation rate at the screening survey. Although the rate in the present study is similar to the participation rates for other college drinking intervention studies that utilized Web-based assessment on the same campus (e.g., Larimer et al., 2007; Neighbors, Lee, Lewis, Fossos, & Larimer, 2007), it is difficult to know how drinking rates or intentions may have affected student decisions to complete the screen. The screened sample was similar to the invited sample in terms of demographics, and the typical drinking in our sample was similar to that of other 21-year-olds who participated in previous research on the same campus. In addition, previous research suggests a curvilinear relationship between typical drinking and choosing to participate in alcohol-related intervention studies, whereby abstainers and extremely heavy drinking students are less likely to participate (Neighbors, Palmer, & Larimer, 2004). Because the present findings indicate that the intervention was more efficacious for those students who intended to reach higher BACs, to the extent that very heavy drinkers may have been less likely to complete screening, low participation rates may mask the effect rates for the intervention. Although the low participation rate was a limitation of the present study, it should be noted that the high follow-up participation rate was a strength.

A second limitation of the present study, as noted above, is the inconsistency between how we assessed protective behavior strategies intentions and the content provided in the intervention. This inconsistency may have undermined our ability to find evidence of an intervention effect on this variable and our ability to evaluate protective behaviors as a mediator of intervention efficacy. In addition, as alluded to in the results, the concurrent assessment of mediators and outcome in the present study limits our ability to draw firm conclusions regarding causal

direction in the mediation change. In the future, researchers who evaluate mediators of ESP interventions should consider including a postintervention assessment to measure potential mediators prior to the specific event being targeted.

Additionally, some research has suggested that self-reported estimated BACs become less accurate with higher actual intoxication levels (i.e., BAC > .08; Carey & Hustad, 2002). Thus, students who reached high BACs may have been less accurate in their reports. Nevertheless, we would expect that if the intervention did not have an effect, the two groups would have reported similar estimated BACs, regardless of the discrepancy between actual and estimated BACs.

Finally, as mentioned above, limitations in the feedback programming precluded us from directly assessing which pages participants viewed or for how long. Future research should address this limitation in its feedback programming, when possible.

Conclusion

Despite a number of limitations, this research provides an important contribution to the literature in documenting the efficacy of a personalized feedback preventative intervention for a specific event associated with extreme alcohol consumption. Results support the focus on personalized BAC information and the inclusion of norms components in event-specific interventions and suggest additional research evaluating the inclusion of protective behavior strategies in this context.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

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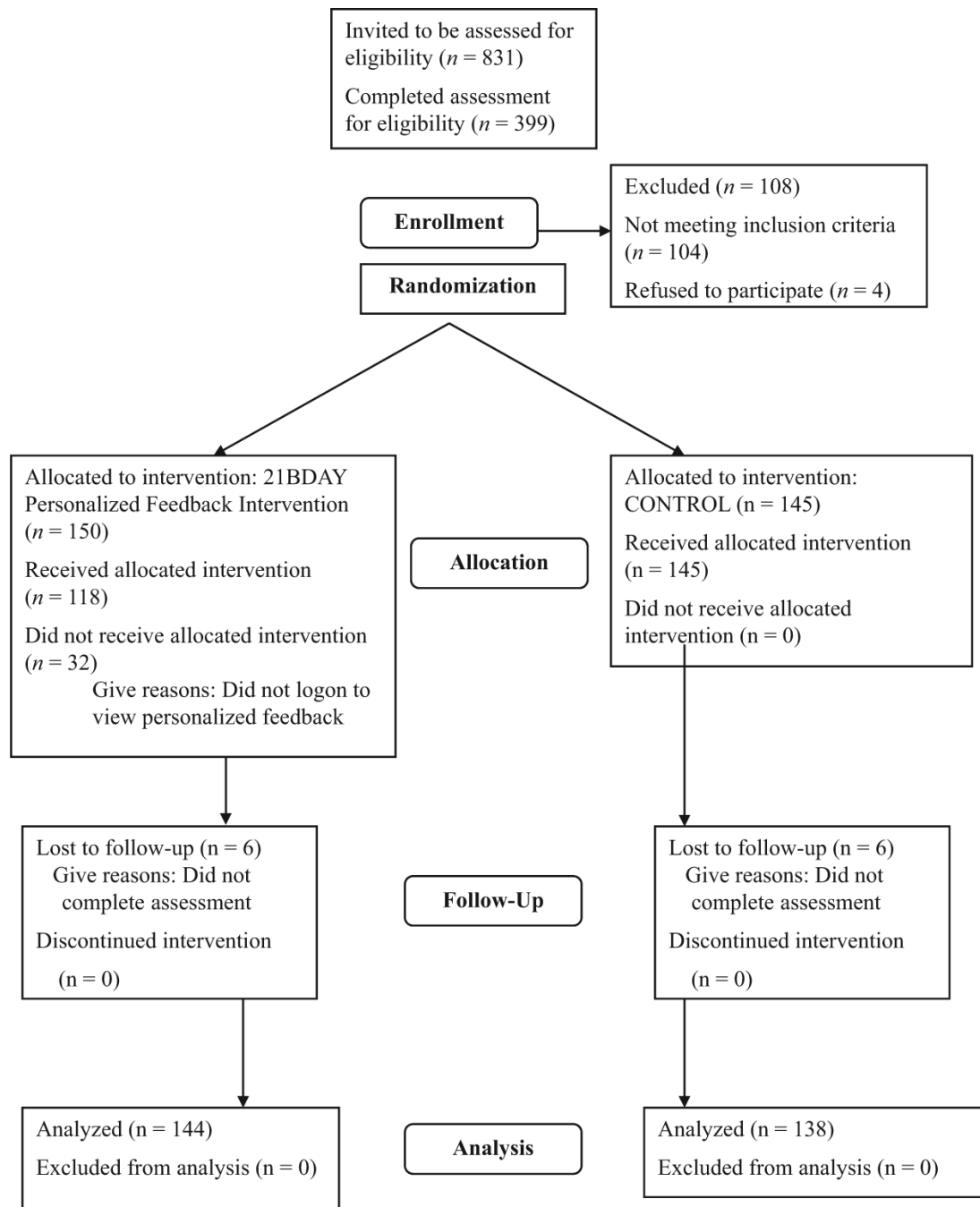
Invited to be assessed for
eligibility (*n* = 831)

Completed assessment
for eligibility (*n* = 399)

Enrollment

Excluded (*n* = 108)

Not meeting inclusion criteria
(*n* = 104)

Refused to participate (*n* = 4)

Randomization

Allocated to intervention: 21BDAY
Personalized Feedback Intervention
(*n* = 150)

Received allocated intervention
(*n* = 118)

Did not receive allocated intervention
(*n* = 32)
    Give reasons: Did not logon to
    view personalized feedback

Allocation

Allocated to intervention:
CONTROL (n = 145)

Received allocated intervention
(n = 145)

Did not receive allocated
intervention (n = 0)

Lost to follow-up (n = 6)
    Give reasons: Did not
    complete assessment

Discontinued intervention

    (n = 0)

Follow-Up

Lost to follow-up (n = 6)
    Give reasons: Did not
    complete assessment

Discontinued intervention

    (n = 0)

Analyzed (n = 144)

Excluded from analysis (n = 0)

Analysis

Analyzed (n = 138)
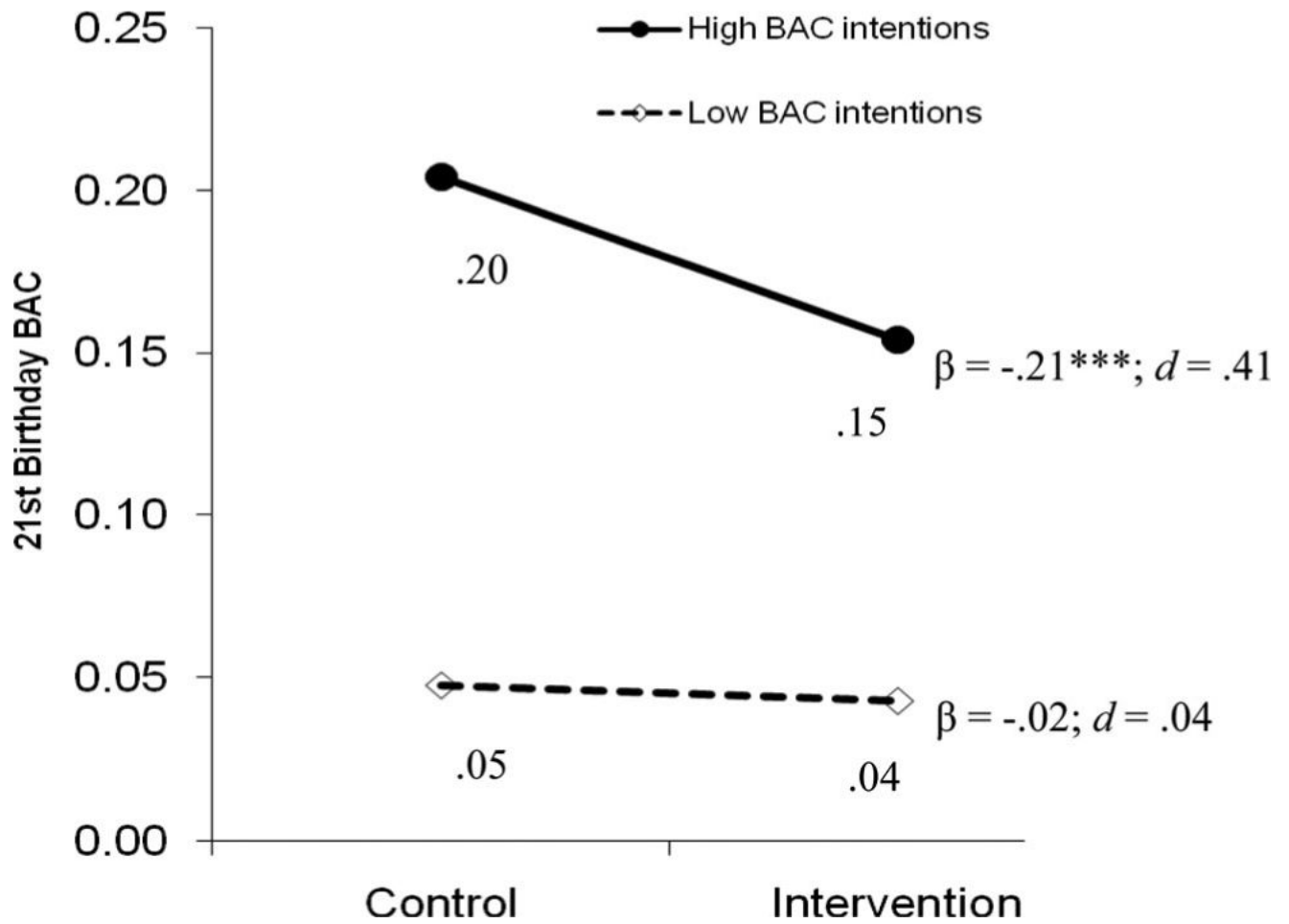
Excluded from analysis (n = 0)

Figure 1.
Participant flow.

Figure 2.
21st-birthday blood alcohol concentration (BAC) as a function of intervention and 21st-birthday BAC intentions. $^{***}p < .001$.
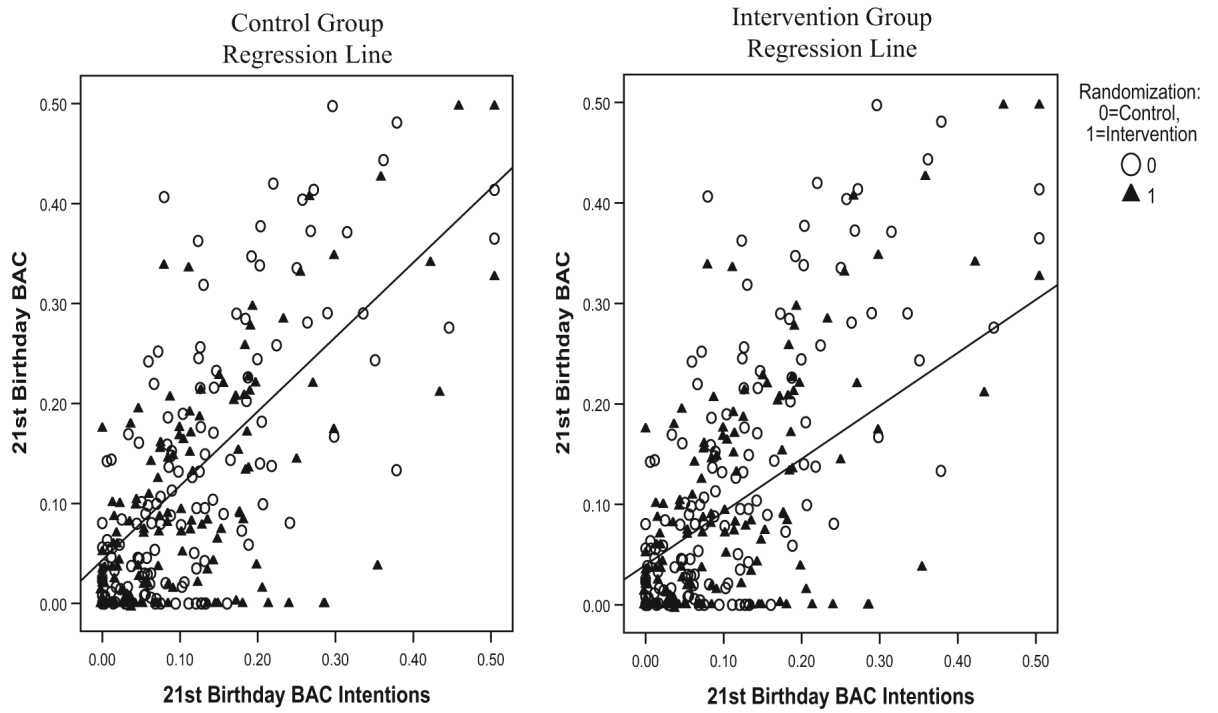
Figure 3.
21st-birthday blood alcohol concentration (BAC) by 21st-birthday BAC intentions scatter plots as a function of intervention condition.
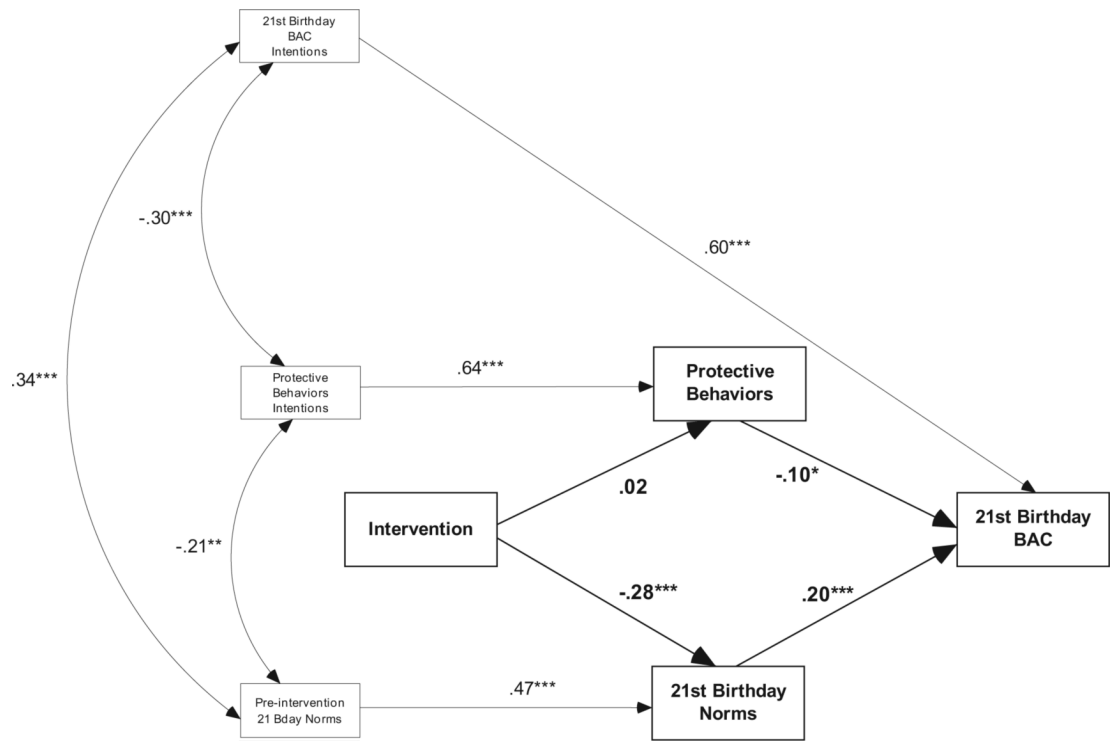
Figure 4.
Mediation model. BAC = blood alcohol concentration. $^{*}p < .05.$ $^{**}p < .01.$ $^{***}p < .001.$

Table 1

Zero-Order Correlations Among Study Variables

Variable	1	2	3	4	5	6	7	8	9
1. Typical weekly drinking	—								
2. 21st-birthday perceived norms (baseline)	.38***	—							
3. 21st-birthday perceived norms (follow-up)	.18***	.47***	—						
4. 21st-birthday protective behaviors intentions	-.43***	-.21***	-.13*	—					
5. 21st-birthday protective behaviors	-.45***	-.29***	-.14*	.64***	—				
6. Intended no. drinks	.55***	.45***	.27***	-.45***	-.39***	—			
7. No. drinks on 21st birthday	.53***	.44***	.36***	-.36***	-.34***	.71***	—		
8. Intended BAC	.44***	.40***	.32***	-.37***	-.29***	.84***	.57***	—	
9. BAC on 21st birthday	.48***	.41***	.41***	-.34***	-.30***	.61***	.86***	.69***	—

Note. Ns ranged from 280 to 294, depending on missing values. BAC = blood alcohol concentration.

*
$p < .05$.

***
$p < .001$.

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Table 2

Means and Standard Deviations for Pre- and Post-birthday Variables by Intervention Condition

Variable	Assessment point	Control condition			Intervention condition		
		N	M	SD	N	M	SD
Typical weekly drinking	Baseline	145	7.92	9.00	149	8.05	9.69
21st-birthday perceived norms	Baseline	143	9.66	4.29	150	9.69	3.96
21st-birthday perceived norms	Follow-up	138	9.81	4.54	144	7.62	2.82
21st-birthday protective behaviors intentions	Baseline	145	4.32	1.03	150	4.57	1.01
21st-birthday protective behaviors	Follow-up	137	6.46	3.42	144	7.07	3.12
Intended no. drinks	Baseline	145	7.14	5.12	150	7.23	5.29
No. drinks on 21st birthday	Follow-up	139	7.00	5.57	144	6.40	6.13
Intended BAC	Baseline	145	0.118	0.107	150	0.111	0.107
BAC on 21st birthday	Follow-up	138	0.129	0.130	144	0.099	0.112

Note. We used different scoring systems to assess 21st-birthday projective behaviors intentions (range = 1-7) and 21st-birthday protective behaviors (range = 0-15). All other baseline-follow-up assessments employed comparable scales. BAC = blood alcohol concentration.

Table 3

Regression Results Evaluating Estimated BAC Reached on 21st Birthday as a Function of Typical Drinking, BAC Intentions, and Intervention Condition

Step and predictor	B	95% confidence intervals, B		SE B	β	t	d
		Lower bound	Upper bound				
Step 1: $R^2 = .51$***							
Intercept	0.126	0.112	0.141	0.007		17.64***	0.57
Typical weekly drinking	0.003	0.002	0.004	0.001	.24	5.08***	0.61
Intended BAC	0.642	0.537	0.747	0.053	.56	12.07***	1.45
Intervention	−0.028	−0.047	−0.008	0.010	−.12	−2.73**	0.33
Step 2: $\Delta R^2 = .01$*							
Intercept	0.126	0.112	0.140	0.007		17.73***	
Typical drinking	0.004	0.002	0.005	0.001	.28	3.97***	0.48
Intended BAC	0.744	0.600	0.888	0.073	.65	10.15***	1.22
Intervention	−0.028	−0.047	−0.008	0.010	−.12	−2.77**	0.33
Typical Drinking × Intervention	−0.001	−0.003	0.002	0.001	−.04	−0.64	0.08
Intended BAC × Intervention	−0.216	−0.424	−0.008	0.106	−.13	−2.05*	0.25

Note. Intervention condition was dummy coded (intervention = 1, control = 0). $N = 281$. BAC = blood alcohol concentration.

*
$p \leq .05$.

**
$p \leq .01$.

***
$p < .001$.