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A text message intervention for alcohol risk reduction among community college students: TMAP

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Abstract

Background: Students at community colleges comprise nearly half of all U.S. college students and show higher risk of heavy drinking and related consequences compared to students at 4-year colleges, but no alcohol safety programs currently target this population.

Objective: To examine the feasibility, acceptability, and preliminary efficacy of an alcohol risk-reduction program delivered through text messaging designed for community college (CC) students.

Methods: Heavy drinking adult CC students (N = 60) were enrolled and randomly assigned to the six-week active intervention (*Text Message Alcohol Program: TMAP*) or a control condition of general motivational (not alcohol related) text messages. TMAP text messages consisted of

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Author contributions

Design of the study: BB, NB, CD and RR.

Collection of data: KW, RT, CD, and RF.

Analysis of data: JF, HT, RR, LS.

Manuscript writing: (first draft) BB, NB & JF. All authors have contributed to the writing and revisions of subsequent drafts and all have reviewed the final draft prior to submission.

Conflict of interest

None of the authors have any actual or potential conflict of interest.

alcohol facts, strategies to limit alcohol use and related risks, and motivational messages. Assessments were conducted at baseline, week 6 (end of treatment) and week 12 (follow up).

Results: Most participants (87%) completed all follow up assessments. Intervention messages received an average rating of 6.8 ($SD = 1.5$) on a 10-point scale. At week six, TMAP participants were less likely than controls to report heavy drinking and negative alcohol consequences. The TMAP group also showed significant increases in self-efficacy to resist drinking in high risk situations between baseline and week six, with no such increase among controls. Results were maintained through the week 12 follow up.

Conclusions: The TMAP alcohol risk reduction program was feasible and highly acceptable indicated by high retention rates through the final follow up assessment and good ratings for the text message content. Reductions in multiple outcomes provide positive indications of intervention efficacy.

Keywords

Alcohol; Text message; Community college; Intervention; mHealth

1. Introduction

Excessive alcohol use is the third-leading preventable cause of death in the U.S. (CDC, 2016), and is a widespread problem among college students (Hingson, Zha, & Weitzman, 2009). Nearly half of all community college students (CCS) engage in heavy alcohol use (Blowers, 2009), similar to the prevalence among students at residential colleges (Hingson et al., 2009; Johnston, O'Malley, Bachman, & Schulenberg, 2013; Wechsler, Lee, Nelson, & Kuo, 2002). However, CCS are at higher risk for negative consequences of heavy drinking including social and health impairment, physical or sexual assault, and unintentional and fatal injuries, and are significantly more likely to drive under the influence compared to students at residential colleges (Blowers, 2009; Hingson et al., 2009; Sheffield, Darkes, Del Boca, & Goldman, 2005; VanKim, Laska, Ehlinger, Lust, & Story, 2010). Despite their high risk and that these students comprise 45% of all college students nationwide (Juszkiewicz, 2014; Knapp, Kelly-Reid, & Ginder, 2012), there has been relatively little effort to assess and intervene with community college students on alcohol-related issues (Seigers & Carey, 2011). While there are currently 1685 community colleges in the U.S. serving over 8 million students (Juszkiewicz, 2014), we were unable to locate any research concerning the development of interventions for alcohol use targeted to CCS.

Efforts are needed to assist this population. CCS differ from students at residential colleges in several important ways. CCS tend to come from lower-income families, have more diverse ethnic/racial backgrounds (Provasnik & Planty, 2008), and typically have multiple roles and responsibilities (e.g., child rearing and employment), which speaks to the need for interventions that are tailored to the needs and life circumstances of this at-risk population. Moreover, community colleges have fewer resources for behavioral risk-prevention interventions compared to residential colleges (Chiauzzi et al., 2011; Sheffield et al., 2005).

Recent research indicates that text messaging using mobile phones is a viable delivery channel that can meet this challenge while also being appropriate for different drinking profiles (Kuntsche & Robert, 2009; Head, Noar, Iannarino, & Grant Harrington, 2013). However, only a few studies have investigated text messaging for alcohol use reduction. Recent studies by Suffoletto, Callaway, Kristan, Kraemer, and Clark (2012) and Suffoletto et al. (2014) have shown reduced drinking among young adult emergency department patients given a 12-week text message delivered intervention compared to controls. A recent meta-analysis of 14 studies examined the effectiveness of text message interventions for tobacco and alcohol cessation within adolescent and young adult populations (Mason, Ola, Zaharakis, & Zhang, 2015). Results showed a summary effect size of 0.25, indicating that, in general, text message delivered interventions have a positive effect on reducing substance use behaviors. Together, these studies indicate that text messaging is a promising method of delivering intervention for alcohol risk reduction. However, the majority of studies to date have been feasibility trials in small samples, studies in populations with mental health comorbidities, or studies in hospital settings (Scott-Sheldon et al., in press). To date, only two have been conducted with college students. One randomized residential college students ($N = 40$) to 2 weeks of text messages or assessment-only control (Weitzel, Bernhardt, Usdan, Mays, & Glanz, 2007). The intervention group showed significant reductions in drinking at post-intervention compared to controls. A second study among 46 residential college students evaluated a 2-week combined alcohol and smoking reduction intervention and found significant reductions in drinking and smoking at 1-month follow-up (Witkiewitz et al., 2014). None of the extant studies have been designed for or conducted among CCS.

1.1. Study objectives

The objectives of this study were to evaluate the (1) feasibility (i.e., number of contacts from interested students, number of eligible participants, achievement of recruitment goals, and the time required to achieve the planned enrollment number), (2) acceptability (i.e., proportion of eligible students who enrolled, the completion rate of study assessments, participant ratings of individual text messages, and participant sharing of text messages), and (3) preliminary efficacy of the *Text Message Alcohol Program* (TMAP) for alcohol-related harm reduction for heavy drinking CC students relative to an attention control condition. The development of TMAP is described in detail elsewhere (Bock et al., 2014, 2015). In brief, the intervention components include information about alcohol-related risks, motivational messages, harm reduction strategies, and evocative questions. We expected that the demand for the intervention would be high, intervention implementation would be efficient, and that the text messages would be perceived favorably (feasibility and acceptability: Bowen, Kreuter, Spring, et al., 2009). We also expected that participants given TMAP would show greater reduction in alcohol use and related problems, increased readiness to change, self-efficacy for alcohol refusal, and use of protective behavioral strategies compared to the comparison condition at the end of the intervention (week 6), and that the group differences would be retained at 12 weeks.

2. Methods

2.1. Study design

We used a two-arm randomized trial to compare TMAP to an attention control condition consisting of general motivational text messages delivered on the same schedule as TMAP messages. Assessments were conducted at enrollment, week six (end of treatment), and week 12 (follow up). All procedures were approved by the Institutional Review Board of the Lifespan Corporation.

2.2. Procedures

2.2.1. Recruitment, enrollment, and randomization—Eligible participants were 18 to 28 years of age, enrolled in community college, reported at least one day in the past 2 weeks of drinking at least 4 drinks, and used text messaging. Participants were recruited through posted flyers at local community colleges. Interested students contacted the research staff who sent an authenticated link to the study screening survey using the student's college email to ensure that they were currently enrolled CC students. The screening survey provided a detailed description of the study. Individuals who met eligibility criteria on the screening survey were relayed to an online consent form followed by the baseline survey. Upon completion of the survey, participants were randomized into one of the two study conditions and were provided instructions to text a phone number associated with their assigned condition to begin receiving text messages. Randomization was stratified by gender and by frequent heavy drinking status, which was defined as three or more heavy drinking episodes (HDE; 4 drinks in one sitting for women and 5 for men) in the past two weeks (Wechsler, Davenport, Dowdall, Moeykens, & Castillo, 1994).

2.2.2. Intervention conditions—Both conditions provided six messages per week for six weeks delivered on the following schedule: Thursday evening ($n = 1$), Friday and Saturday evenings ($n = 2$ each), and Sunday evening ($n = 1$). Each text was followed by a brief message requesting that the participant rate the text from 1 (“not at all”) to 10 (“liked it a lot”). If no reply was received within 30 min, a reminder text was sent asking the participant to rate the previous message.

2.2.2.1. TMAP intervention.: In the TMAP condition, the intervention texts were written in three broad domains: 1) Facts about alcohol, 2) Strategies to limit alcohol use and alcohol-related risks, and 3) Motivational messages. Within each of these domains, messages represented the following content categories: Pregaming, Safety, Caring, Driving/social responsibility, Consequences, Limits/strategies, Awareness of physical sensations related to alcohol use/over-use, Planning, and Fun/emotion/social topics (Table 1). TMAP participants could also text any of five key words at anytime: TAXI or CAB, COST or MONEY, BAC, TIPS, and PARTY OR CLUB. Texting a Key Word generated a reply providing a particular service or link to the participant (Table 1).

2.2.2.2. Control condition.: For the control arm we used a subscription text service provided by Live Inspired LLC. Texts from this service are general motivational messages that are not focused on alcohol use or harm reduction (e.g., “*Have high hopes and work*

diligently to make your hopes become haves.”), and were delivered on the same schedule as TMAP messages.

2.2.3. Post-intervention and follow-up assessments—At 6 and 12 weeks after enrollment, all participants were emailed a link to online follow-up assessments. Participants who completed the surveys received \$30.00 for each time point.

2.3. Measures

2.3.1. Demographic information—At baseline participants reported their age, gender, race, ethnicity, education (full/part time), method of commuting to school, work status, living arrangements (e.g., live alone and with spouse) and weight (used to estimate blood alcohol concentration; eBAC [Matthews & Miller, 1979]).

2.3.2. Alcohol use measures—Assessments of alcohol use included a 2-week alcohol Timeline Followback measure of alcohol use used to determine study eligibility at screening (Sobell & Sobell, 1992). A standard drink was defined as a 12-ounce beer or wine cooler, a 5-ounce glass of wine, one mixed drink, or 1 shot of liquor (NIAAA, 2004, 2015). The Alcohol Use Graduated Frequency Survey (GFS; Hilton, 1989), a 6-item measure of alcohol consumption over the past two weeks was used to assess drinking patterns (e.g., number of drinks per day, number of days per week), and the number of heavy drinking episodes (HDE) at baseline, 6 and 12 week follow up. Peak eBAC was calculated using the highest number of drinks and time spent consuming them. The 24-item Brief Young Adult Alcohol Consequences Questionnaire (BYAACQ; Kahler, Hustad, Barnett, Strong, & Borsari, 2008; Kahler, Strong, & Read, 2005) was used to assess the number of negative alcohol-related consequences experienced during the past six weeks. Items are dichotomous (no/yes) and summed ($\alpha = 0.81$).

2.3.3. Process outcomes—We assessed self-efficacy for reducing heavy drinking using 7 items from the Brief Situational Confidence Questionnaire (Breslin, Sobell, Sobell, & Agrawal, 2000).¹ Readiness to reduce drinking was assessed using the 4-item contemplation subscale of the Readiness to Change measure (Rollnick, Heather, Gold, & Hall, 1992). A 14-item instrument assessed the use of protective behavioral strategies (PBS) to limit drinking (Werch, 1990).

2.3.4. Feasibility—Feasibility of the intervention was determined by evaluating the number of contacts from interested students, the number of eligible participants, achieving the planned recruitment goal ($N = 40$), and the length of time it took to achieve our enrollment number.

2.3.5. Acceptability—Acceptability of the intervention was determined by evaluating the proportion of eligible students who enrolled, the completion rate of study assessments, participant ratings of individual text messages, and whether they shared the texts with anyone. Text sharing was assessed at week six. Participants were asked three questions:

¹One item about testing control over use of alcohol was removed because it assumes the participant identifies alcohol use as a problem, which was not a reasonable assumption for this sample.

whether they had shared any of the texts with anyone, what proportion of their texts they shared, and with whom (e.g., friend, family member).

2.4. Statistical analyses

We conducted all descriptive and outcome analyses using SAS version 9.4 (SAS Institute, Cary, NC). We first examined for intervention group differences on baseline demographic characteristics and baseline values of key dependent variables using analysis of variance (ANOVA) or chi-square tests for continuous or categorical variables, respectively. We conducted outcome analyses at two time points: immediately after the 6-week intervention ended (i.e., post-treatment) and at follow up (12 weeks after baseline). At post-treatment we used logistic regression analysis for categorical outcome variables and repeated measures linear mixed model analysis for change in continuous outcome variables from baseline to post-treatment, where the group by treatment interaction effect was examined for group differences. For a few continuous variables, such as eBAC,² there was no appropriate baseline measure to compare change across time to post-treatment, so group differences were assessed by cross-sectional ANOVA.

For analyses of the 12-week follow-up data when the data were categorical, we employed generalized estimating equations (GEE) (Liang, Zeger, & Qaqish, 1992) with robust standard errors as implemented within Proc GENMOD. For longitudinal analyses that examined for treatment group differences using continuous outcome variables, we conducted longitudinal linear mixed model analyses fit with an autoregressive covariance structure. For this we used the Proc MIXED procedure within SAS and accommodated missing values under the assumption of missing at random (Little & Rubin, 2002), which allowed us to maximize use of the existing data.

3. Results

3.1. Participants

Participants were 23 male and 37 female adults randomized to the TMAP ($n = 31$) and control ($n = 29$) arms. Participants averaged 21.8 years of age ($SD = 3.0$, range 18–28). Nearly half the sample (45.0%) was under age 21. Most participants were white/Caucasian (81.7%), 6.7% Asian, 1.7% Native American, 3.4% multiracial and 5% unknown. In addition, 10.0% of all participants were Hispanic. The majority (68.3%) were enrolled as full-time students, and were employed either full- (21.7%) or part-time (61.7%). Most participants lived with their parents (58.1%), with a roommate (21%) or in mixed family groups (17.7%). Nearly one fifth (18.9%) of women (no men) reported having children of their own, and of those 71.4% were single mothers. Most (88.3%) drove alone to school an average of 10.7 miles ($SD = 8.6$, range: 1–45 miles). Demographics are presented in Table 2.

The average number of drinking days reported for the 2 weeks prior to study enrollment was 5.3 ($SD = 3.0$) and the average number of drinks in the past 2 weeks was 44.4 ($SD = 40.9$). At baseline participants reported an average of 3.91 ($SD = 3.67$) HDEs in the past 2 weeks,

²We erroneously did not collect the necessary information to calculate eBAC at baseline.

and 36.7% of participants were classified as frequent heavy drinkers, with 3 or more HDEs in the previous 2 weeks. Nearly half (43.2%, $n = 16$) of all women and approximately one quarter (26.1%, $n = 6$) of all men were classified as “frequent heavy drinkers” for randomization.

3.2. Feasibility and acceptability

Our goal was to recruit a sample of 40 individuals, and we were able to exceed this goal by 25% in one month. During four weeks of recruitment, 130 individuals clicked the emailed link to the study website and 123 (94.6%) completed the screener survey. Of these, 65 (52.8%) were eligible and 62 enrolled in the study (enrollment rate of 95.4%; 61.3% women). Two participants (1 man and 1 woman) provided invalid/inconsistent responses to key outcome measures at baseline, and were removed, leaving 60 participants. The most common reasons for ineligibility were drinking below the minimum inclusion criterion ($n = 33$), and not drinking at all in the past 2 weeks ($n = 22$). No system outages occurred during the study. Only one participant did not receive some scheduled texts. This was due to changing phones during the intervention. No participants texted “STOP” to end their participation in the study.

Overall 93.3% ($n = 56$) of participants completed the six-week assessment and 88.3% ($n = 53$) completed the final follow-up assessment. Nearly all (92.4%) text messages sent by the study received rating responses from participants. Intervention (TMAP) messages received an overall average rating of 6.79 ($SD = 1.49$) on a 10-point Likert scale while messages in the control arm received mean ratings of 7.44 ($SD = 1.41$). There was no significant difference in ratings of message liking between TMAP and control arms of the study.

In the TMAP condition, no significant differences were seen in overall ratings for type of message (i.e., Facts, Strategies, Motivational messages). No differences were seen in message ratings by participant gender, however, motivational messages received lower liking ratings from frequent heavy drinkers ($M = 6.1$, $SD = 1.6$; $p = 0.03$) than from other participants ($M = 7.3$, $SD = 1.4$). Motivational messages were also liked more by those under age 21 ($M = 7.6$, $SD = 1.6$) compared to those 21 and older ($M = 6.4$, $SD = 1.4$; $p = 0.03$). A total of 88.1% of participants shared the program text messages with others, including 90.3% of TMAP and 85.7% of controls. There were no significant differences between groups for text sharing.

3.3. Alcohol use outcomes

At post-treatment, TMAP participants were more likely (51.6% vs. 27.6%) to report 1 HDE in the past 2 weeks compared to controls [$OR = 2.80$ (95% CI = 0.95, 8.22), $p = 0.06$, $d = 0.62$]. At week 12, group differences were still in the expected direction, with 48.4% TMAP vs. 34.5% control participants reporting 1 HDE in the past 2 weeks [$OR = 1.78$ (95% CI = 0.63, 5.04), $p = 0.28$, $d = 0.35$]. A GEE analysis across time (post-treatment to follow-up) found a main effect for group that approached significance, [$OR = 2.23$ (95% CI = 0.91, 5.49), $p = 0.08$], while there was no significant effect for time ($p = 0.73$) or the group by time interaction ($p = 0.43$).

Using ANOVA, the group difference for peak eBAC at post-treatment also approached significance ($M = 0.11$, $SD = 0.07$ for TMAP vs. $M = 0.14$, $SD = 0.06$ for control; $p = 0.10$, $d = 0.46$). At follow up a longitudinal linear mixed analysis indicated no significant group effect ($p = 0.18$) and group by time interaction ($p = 0.23$), with a near significant effect for time ($p = 0.09$), as both groups had further reduced peak blood alcohol concentration at 12 weeks ($M = 0.10$, $SD = 0.06$ for TMAP vs. $M = 0.11$, $SD = 0.08$ for control; $d = 0.13$).

At post-intervention, TMAP participants were significantly more likely (35.5% vs. 10.3%) to report zero negative alcohol consequences on the BYAACQ compared to controls [$OR = 4.77$ (95% CI = 1.17, 19.40), $p = 0.03$, $d = 0.93$]. Results were similar (though no longer significant) at follow up, with 38.7% of TMAP participants reporting zero negative alcohol consequences in the past 2 weeks compared to 17.2% in the control group [$OR = 3.03$ (95% CI = 0.91, 10.11), $p = 0.07$, $d = 0.66$]. A GEE analysis across time from post-treatment to follow up found a significant main effect for group [$OR = 3.80$ (95% CI = 1.32, 10.92), $p = 0.02$], while there was no significant effect for time ($p = 0.35$) or the group by time interaction ($p = 0.56$).

3.4. Psychosocial variables

An examination of change in self-efficacy to limit drinking from baseline to 6 weeks, found an overall significant effect across time ($p < 0.01$), but the group by time effect ($p = 0.16$) and group effect ($p = 0.59$) were not significant. Within-group comparisons for change across time found a significant increase ($p < 0.01$) for TMAP participants in confidence in their ability to limit drinking from baseline to week 6 (baseline: $M = 58.4$, $SE = 4.1$; 6 weeks: $M = 71.8$, $SE = 4.1$; $d = 0.51$), but not for controls from baseline to week 6 post-intervention (baseline: $M = 59.7$, $SE = 4.2$; 6 weeks: $M = 64.9$, $SE = 4.4$; $p = 0.23$; $d = 0.27$). Similar results were observed for the 12-week assessment data. Within-group analyses showed significant increases from baseline to 12 weeks for confidence among TMAP participants ($M = 71.5$, $SE = 4.2$; $p = 0.003$, $d = 0.50$), but not among controls ($M = 68.8$, $SE = 4.6$; $p = 0.06$, $d = 0.48$).

An examination of Readiness to Change (Rollnick) from baseline to 6 weeks found a significant group by time effect ($p = 0.05$), but no significant effect for time ($p = 0.41$) or group ($p = 0.77$). To investigate the interaction effect, we analyzed within-group changes across time and found a significant ($p = 0.05$) decrease in readiness for controls from baseline to post-intervention (baseline: $M = 0.00$, $SE = 0.67$; post-intervention: $M = -1.13$, $SE = 0.68$; $d = -0.35$), and a non-significant change ($p = 0.38$) for TMAP participants from baseline to post-intervention (baseline: $M = -1.06$, $SE = 0.65$; post-intervention: $M = -0.58$, $SE = 0.65$; $d = 0.12$). Including the 12-week assessment in the analyses, however, found no significant group by time interaction ($p = 0.16$), time ($p = 0.51$), and group effects ($p = 0.73$). Within-group effect sizes (d) for changes from baseline to 12 weeks were -0.07 and -0.18 for the TMAP and control groups, respectively.

We examined the number of PBS to limit drinking and found a marginally significant group by time effect from baseline to six weeks ($p = 0.10$), but no significant effect for group ($p = 0.79$) or time ($p = 0.33$). Within-group comparisons for change across time found a marginally significant decrease ($p = 0.07$) in the number of strategies to limit drinking from

baseline to 6 weeks among control participants (baseline: $M=43.6$, $SE=1.8$; 6 weeks: $M=40.4$, $SE=1.8$; $d=-0.41$), but not for TMAP (baseline: $M=42.2$, $SE=1.7$; 6 weeks: $M=43.0$, $SE=1.7$; $p=0.61$; $d=0.09$). Including the 12-week assessment in the analyses showed similar results with no significant group by time interaction ($p=0.21$), group effect ($p=0.71$), or time effect ($p=0.55$). Trends in the data indicated that controls reported fewer strategies to limit drinking from baseline to 12 weeks ($M=40.8$, $SE=2.0$; $p=0.21$, $d=-0.35$) but PBS were maintained among TMAP participants ($M=42.2$, $SE=1.8$; $p=1.00$, $d=0.00$).

4. Discussion

Results indicate that the TMAP alcohol risk reduction program is feasible and highly acceptable based on our enrollment of eligible participants, good ratings of our text message content, and participant retention. The targeted enrollment was easily met within one month with good representation of both genders (38.7% men), those under the legal drinking age (43.5% under 21), and those who were high-risk heavy drinkers (35.5%).

Although the study was not statistically powered to achieve significance, positive changes were observed in drinking behaviors favoring the active intervention, many of which achieved near significance, despite the small sample size. The magnitude of the differences in drinking behaviors between TMAP and Mojo were small to large (post-treatment: $d_+ = 0.46-0.62$; 12-week follow-up: $d_+ = 0.13-0.35$). These effect sizes were similar to (and in some cases stronger than) those reported in meta-analyses of text-messaging interventions to reduce or improve health-related behaviors (e.g., Head et al., 2013, $d_+ = 0.33$; Mason et al., 2015, $d_+ = 0.25$) and computer-delivered alcohol interventions for college students (Carey, Scott-Sheldon, Elliott, Bolles, & Carey, 2009, $d_+ = 0.02-0.16$). We also observed significant reductions in negative consequences of drinking in the intervention group, indicating that the purpose of the intervention, harm reduction, was achieved.

Changes in psychosocial factors that might be posited to mediate changes in drinking behavior (i.e., self-efficacy, readiness to limit drinking) also favored the intervention group. We also found that during the follow up period, participants in the TMAP condition continued to use protective behavioral strategies to limit drinking whereas participants in the control group reduced the number of protective behavioral strategies used from baseline to follow-ups. This finding is particularly important in that the TMAP intervention provided text messages that gave specific information about using these strategies to limit drinking; suggesting that participants were adopting some of these strategies even though the study's stated aim was not focused on limiting drinking.

In a similar study, Suffoletto et al. (2014) tested a text message intervention to reduce binge drinking among young adult emergency department patients. Though findings were promising, that study observed a steady decrease in response rates over the 12-week intervention. Suffoletto observed that future SMS interventions may need to incorporate additional behavioral techniques to promote continued participation in the program and to avoid participant attrition. The TMAP intervention incorporated goal setting (planning) on Thursdays and a retrospective assessment of drinking on Sundays similar to Suffoletto et al.

(2014), but TMAP also provided texts aimed at increasing motivation and strategies promoting harm reduction, safe drinking, and techniques to limit drinking. The additional contact and richer content of the TMAP intervention may have helped promote longer program engagement. TMAP message content was also developed in collaboration with our target audience to promote cultural consistency and an authenticity in message tone (Bock et al., 2015). This too may have helped promote intervention engagement.

It is an open question whether messages designed first and foremost to reduce or eliminate drinking may be more or less engaging and/or effective compared with messages designed primarily to limit harm from drinking. TMAP was designed to reduce alcohol harm and did not include messages asking participants to stop drinking. This strategy was based on our formative work where young adults were particularly reactive to messages designed to limit drinking, “Don’t tell me not to drink, tell me you care how I drink.” (Bock et al., 2015). Harm reduction messages delivered through an innovative text-based system is a strength of this research and may account for the high response and retention rates in this study. Importantly, reduction in hazardous drinking and alcohol-associated harm was detected, suggesting the approach was successful.

While changes in heavy drinking and eBAC were more pronounced among TMAP participants, we also observed reductions in these measures among controls. This finding is similar to other studies which have documented that assessment alone can produce reductions in drinking behaviors (Hufford, Shields, Shiffman, Paty, & Balabanis, 2002). Nonetheless, TMAP participants showed greater reductions in drinking behaviors and significant changes in psychosocial factors posited to mediate intervention efficacy, although the scope of our trial was not sufficient to test mediational hypotheses. Larger-scale trials with optimal statistical power are needed to determine how these interventions are producing their effects and for whom they can be most effective (Scott-Sheldon et al., 2016).

4.1. Limitations

Since eligibility criteria required minimum alcohol consumption, the acceptability of this intervention for CCS who are light drinkers, or who don’t drink, is not established. However, it was an acceptable approach to students who are at highest risk of harm from drinking.

Participants were compensated for responding to text messages during the 6-week program, and for completing surveys at 6 and 12 weeks. Thus retention of participants may be less robust if this intervention were deployed in a college setting where compensation is not offered. This may be mitigated somewhat by limitations placed on the study by the institutional review board which does not permit compensation to be included in study advertisements. In addition, if this program is adopted and disseminated, colleges that might make participation mandatory or offer other incentives for those who participate, thus mimicking the effects of research study compensation.

Future studies with sufficient statistical power to assess the impact of posited mechanisms (mediators) are needed in order to take research into SMS (and other technology) delivered interventions beyond simple questions of efficacy and gain a deeper understanding of how

these interventions work and for whom (de la Vega & Miro, 2014; Riley et al., 2011; Scott-Sheldon et al., in press).

5. Conclusion

Overall, TMAP provides encouraging results and justifies the need for larger efficacy trial that also examines the pathways for intervention effects.

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HIGHLIGHTS

- TMAP showed excellent feasibility, acceptability, recruitment and retention.
- TMAP participants reduced heavy drinking episodes compared to controls.
- TMAP significantly reduced negative consequences of alcohol use.
- TMAP participants increased confidence in their ability to limit drinking.

Table 1

Examples of text messages, topic categories and key words contained in the TMAP intervention program.

Category	Example text
Pregaming	Don't let your pre-game ruin the big game. Pace yourself and know your limit
Safety	Always have an exit plan
Caring	Be responsible tonight, you are important to a lot of people.
Driving/social responsibility	Who are you with tonight, who's the designated driver?
Consequences	Let's just pretend that it's tomorrow morning, where do you want to be when you wake up?
Limits/strategies	Set a limit for yourself tonight, avoid a hangover tomorrow
Physical sensations	When you notice your face getting closer and closer to the phone screen I think that's a reminder you had enough.
Planning	Not sure who's driving home later? Go ahead and look up the number for a cab, just in case
Fun/emotional/social	Having a blast? It's not the alcohol that's fun - YOU ARE!
Key word	Function
TAXI or CAB	Reply text with phone numbers for local cab companies
COST or MONEY	Link to online cost calculator
BAC	Link to online blood alcohol calculator
TIPS	Reply text with a series of tips on safe drinking strategies
PARTY or CLUB	Reply text with strategies for staying safe in a club/party setting
PHONE	Reply text with study phone number
STOP	Stopped all study related texts. Reply text: "okay, we will stop the program. We will call you later to see what's up"

Note. Two messages about alcohol-risks of particular interest to women were provided to women enrolled in the study in place of two general alcohol fact messages ("*Drinking makes young women more vulnerable to sexual assault and unsafe and unplanned sex*". "*Women absorb alcohol more slowly than men, so we get drunk faster and stay drunk longer. Pace yourself. Go slow. Stay safe.*").

Table 2

Participant characteristics overall and by treatment group at baseline assessment.

Variable	TMAP (<i>n</i> = 31)		Control (<i>n</i> = 29)		Total (<i>N</i> = 60)		Statistic	<i>p</i>
	Mean (<i>SD</i>)/percent (<i>N</i>)	Mean (<i>SD</i>)/percent (<i>N</i>)	Mean (<i>SD</i>)/percent (<i>N</i>)	Mean (<i>SD</i>)/percent (<i>N</i>)				
Age	22.0 (3.2)	21.5 (2.8)	21.8 (3.0)	F(1,58) = 0.56	0.46			
Female	61.3% (<i>n</i> = 19)	62.1% (<i>n</i> = 18)	61.7% (<i>n</i> = 37)	$\chi^2(1) = 0.004$	0.95			
White/Caucasian	83.9% (<i>n</i> = 26)	77.4% (<i>n</i> = 24)	81.7% (<i>n</i> = 49)	$\chi^2(1) = 0.57$	0.45			
Hispanic	6.5% (<i>n</i> = 2)	13.8% (<i>n</i> = 4)	10.0% (<i>n</i> = 6)	$\chi^2(1) = 0.90$	0.34			
Full-time student	74.2% (<i>n</i> = 23)	62.1% (<i>n</i> = 18)	68.3% (<i>n</i> = 41)	$\chi^2(1) = 1.02$	0.31			
Employed								
Full-time	19.4% (<i>n</i> = 6)	24.1% (<i>n</i> = 7)	21.7% (<i>n</i> = 13)	$\chi^2(2) = 3.86$	0.15			
Part-time	54.8% (<i>n</i> = 17)	69.0% (<i>n</i> = 20)	61.7% (<i>n</i> = 37)					
Not employed	25.8% (<i>n</i> = 8)	6.9% (<i>n</i> = 2)	16.7% (<i>n</i> = 10)					
Alcohol use								
# drink days/month	18.6 (10.0)	21.1 (9.2)	19.8 (9.6)	F(1,58) = 1.06	0.31			
# hvy drink days/month	6.7 (7.3)	7.6 (5.2)	7.1 (6.3)	F(1,58) = 1.04	0.31 ^a			
Drink days in past 2 weeks	5.6 (3.3)	4.7 (2.3)	5.1 (2.9)	F(1,57) = 1.51	0.23			
# drinks per drink day	4.7 (3.0)	4.3 (1.6)	4.5 (2.4)	F(1,58) = 0.05	0.83 ^b			
Ave drinks per past 2 weeks	44.5 (50.0)	44.4 (29.0)	44.4 (40.9)	F(1,58) = 0.82	0.37 ^b			
Negative consequences (BYAACQ)	9.5 (4.9)	9.4 (4.4)	9.5 (4.6)	F(1,58) = 0.00	0.99			
Negative consequences (BYAACQ: 0 vs. any)	3.2% (<i>n</i> = 1)	0.0% (<i>n</i> = 0)	1.7% (<i>n</i> = 1)	$\chi^2(1) = 0.95$	0.33			
Brief Situational Confidence	58.4 (25.6)	59.7 (18.4)	59.0 (22.2)	F(1,58) = 0.05	0.82			
Strategies to limit drinking	1.8 (0.7)	1.9 (0.6)	1.8 (0.6)	F(1,58) = 0.01	0.93			

^aReported F-test value and *p*-value are based on Square Root transformation used to correct for non-normality in data structure. Actual (non-transformed) means and standard deviations are presented in the table.

^bReported F-test value and *p*-value are based on Natural Log transformation used to correct for non-normality in data structure. Actual (non-transformed) means and standard deviations are presented in the table.