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ORIGINAL PAPER

A Preliminary Randomized Controlled Trial of Game Plan, A Web Application to Help Men Who Have Sex with Men Reduce Their HIV Risk and Alcohol Use

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Abstract
Alcohol use is a key risk factor for HIV infection among men who have sex with men (MSM). Past studies show that brief motivational interventions (BMI) can increase the use of prevention methods (e.g., condoms), reduce alcohol use, and can be adapted for web-based delivery. However, few studies have explored these interventions' effects in MSM. Forty high-risk, heavy drinking MSM who sought rapid HIV testing were randomly assigned to receive either (1) standard post-test counseling (SPC) alone, or (2) SPC plus Game Plan (GP), a tablet tablet-based BMI for alcohol use and HIV risk. Over three months of follow-up, GP participants reported 24% fewer heavy drinking days, 17% fewer alcohol problems, and 50% fewer new anal sex partners than controls. GP participants also reported fewer high-risk condomless anal sex events than controls, but these differences were not significant. These initial results suggest that web-based BMIs may be promising tools to help MSM reduce health risk behaviors.

Keywords Alcohol · Men who have sex with men · HIV risk behavior · Condom use · Brief intervention · Web-based intervention

Introduction

In the United States, HIV incidence continues to increase among certain subgroups of men who have sex with men (MSM) [1], including young MSM aged 25–34 [2]. MSM accounted for 67% of all new infections in 2015 [3], and recent analyses show that, if these rates continue, 1 in 6 MSM will be diagnosed with HIV in their lifetimes [4]. Although new biomedical prevention methods like pre-exposure prophylaxis (PrEP) show promise for reducing incidence [5, 6], uptake is currently < 5% of all eligible MSM [7]. Rates of condom use during anal sex also continue to be inadequate among many MSM [8, 9], contributing to new HIV infections and record high rates of other sexually transmitted infections (STIs) [10–14].

Alcohol use is a key risk factor for HIV infection among MSM [15–17] due in large part to alcohol's tendency to interfere with the use of effective prevention methods like condoms [18–21]. Binge drinking (5 + drinks on a single occasion) is of particular concern, since drinking at this level is consistently associated with failing to use a condom during anal sex with high-risk partners among MSM [21–23]. Innovative and scalable interventions are needed to encourage MSM to adopt effective prevention methods (e.g., condoms, PrEP) and use them consistently, and to address binge drinking as a co-occurring transmission risk factor.

Meta-analyses have shown that behavior change interventions can increase recipients' use of HIV/STI prevention methods like condoms, and that their effects may be especially pronounced among MSM [24–26]. Brief interventions for alcohol use have received broad support, with several meta-analyses showing that these interventions are often as effective as their longer, more extensive counterparts [27–29]. In particular, brief interventions inspired by motivational interviewing have some of the most robust empirical support [27, 30]. Recent studies have shown greater reductions in alcohol use among heavy drinkers who received a brief motivational intervention (BMI) in HIV primary

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care settings, when compared with brief education/advice [31, 32]. Monti et al. [33] showed that a dual-behavior BMI reduced both heavy drinking and high-risk sexual behavior compared to brief advice over 9 months of follow-up, among at-risk heterosexual male and female emergency department patients. Kahler et al. [34] also found that, in a sample of MSM living with HIV, a BMI compared to assessment only significantly reduced alcohol consumption and condomless sex with non-steady partners among men who reported this behavior prior to the intervention.

Despite evidence of efficacy, face-to-face interventions like these have a number of challenges that have so far limited their impact [35, 36]. In particular, implementing these interventions in busy healthcare settings where they are often most needed is cost and resource-intensive, in part due to the need for highly-trained staff capable of delivering them with fidelity. Personalized feedback interventions (PFIs) are one type of BMI that has been adapted for digital and web-based delivery using a self-guided format [37], and could overcome many of these challenges. PFIs are inspired by principles of MI and aim to develop discrepancy between recipients' current and desired behavior by providing personalized feedback about current behavior and comparing it with a relevant social group [38, 39]. Although direct comparisons between these digitally-delivered alcohol PFIs and those delivered face-to-face show that, as a whole, the effects of face-to-face interventions may be more durable, both types of PFIs show reductions in alcohol use [40–43], and some well-designed digital PFIs for alcohol use may perform as well as similar face-to-face interventions [44]. Although digitally-delivered interventions have also been shown to increase condom use among MSM [45], no studies have yet explored whether digitally-delivered alcohol or dual-behavior interventions can help MSM reduce heavy drinking and HIV risk behavior.

The effects of brief alcohol and HIV interventions may be most profound when they are delivered soon after recipients experience negative consequences of a behavior (i.e., "teachable moments") [46–48]. With respect to alcohol use, studies have shown that those who receive a BMI after an alcohol-related incident (an event that required medical, police, or administrative attention) showed greater reductions in drinking than those who received them at an unrelated time [48–50]. With respect to HIV, voluntary testing is often sought after a possible sexual exposure to HIV [51, 52]; up to 60% of MSM in one sample listed this as a key reason for testing [53]. As such, HIV testing could be an optimal time to intervene in order to reduce alcohol use and HIV risk. Counseling is already offered alongside voluntary HIV testing in many settings, and there are guidelines on its content [54]. However, in practice, no specific approach to counseling is used consistently [55], and alcohol use is rarely addressed. Moreover, Metsch et al. [56] found that a broad, "person-centered" post-test counseling approach that aligned with CDC recommendations did not reduce STI incidence or sexual risk behavior among MSM compared to information alone. Although these findings have widely been construed as evidence that providing counseling alongside testing does not reduce risk, they may instead suggest that for post-test counseling to be effective, it must involve a more consistent, theoretically-informed, and empirically-supported approach to behavior change that addresses key factors that contribute to risk behavior. Internet-facilitated approaches could help capitalize on these "teachable moments," while also delivering consistent, theoretically-informed content that helps MSM change to reduce their risk.

Given these needs, we developed Game Plan (GP), an interactive web application that is optimized for tablet computers and aims to help high-risk MSM consider reducing their HIV-risk behavior and alcohol use after they test negative for HIV at a clinic. A full description of GP's content has been reported elsewhere [57]. The core features of GP include: providing personalized, digestible, and engaging feedback about recipients' level of drinking and risk for HIV, and comparing this with other gay/bisexual men in their age group; incorporating reflective exercises similar to those often used in MI sessions that are intended to elicit "change talk"; engaging recipients in game-like activities to develop further discrepancy and promote personalized HIV and alcohol risk reduction goals and change planning. GP was also developed using a thorough user-centered design process [58, 59] that helped ensure it was engaging to its intended users (heavy drinking, high-risk MSM) and generally aligned with the "spirit" of MI.

In this preliminary study, we explored initial evidence of GP's promise by testing whether MSM who used the GP app on a tablet after completing HIV testing and post-test counseling reduced their alcohol use and sexual risk behavior compared with HIV who received HIV testing and post-test counseling alone. Specifically, we examined descriptive data on a number of important antecedents of change for both alcohol and sexual risk behavior that were collected within the app, such as changes in participants' motivation to change and behavior change goals. Next, we explored whether those who used GP reported fewer drinking days, binge drinking days (i.e., days on which 5 + drinks were consumed), and a lower average number of drinks per drinking day, compared to those receiving post-test counseling alone. We also explored whether more participants in the GP condition would consult with a medical provider about starting PrEP, receive PrEP prescriptions, and report a fewer number of anal sex partners, as well as condomless anal sex (CAS) events with new and unknown status partners.

Methods

Participants

Forty MSM in the Northeastern US were recruited to receive free rapid HIV testing from gay-oriented smartphone dating apps (e.g., Grindr, Scruff) and enrolled between October and December 2017. Eligible participants were (1) assigned male sex at birth, (2) over age 18, (3) able to read in English, (4) reported CAS with male partner of unknown HIV status in the past 3 months, (5) had not tested for HIV in the last 6 months, and (6) were HIV-negative or unsure of their status. They also were (7) classified as "heavy drinkers" using NIAAA criteria, meaning that they reported consuming at least 14 drinks on an average week or drinking ≥ 5 drinks in a single sitting at least once in the past month. Those who (8) were currently receiving medications or counseling for an alcohol or drug-related problem were excluded, since ongoing treatment may have interfered with the study's primary outcomes. Those who reported (9) currently taking pre-exposure prophylaxis (PrEP) were also excluded, since a key goal of the study was to explore whether those who used GP were more likely to seek and start PrEP. As this was an exploratory RCT, a priori power analyses were not conducted to determine the final sample size. However, given that past studies have shown small-to-medium effects for similar interventions on related outcomes [33, 43, 60], we chose a sample size of $N = 40$ a priori to align with existing recommendations for two-arm exploratory trials with effects of this size [61, 62].

Procedures

Figure 1 shows the Consolidated Standards of Reporting Trials (CONSORT) flow diagram of participants through study milestones [63]. Advertisements offering free HIV testing were presented to users of selected dating apps who logged in within a 30-mile radius of Providence. Those interested were directed to a study landing page, where they completed a brief online survey before scheduling a testing appointment using an online scheduling system. At these appointments, all participants were first tested for HIV using a rapid test (OraSure's OraQuick Rapid HIV Antibody Test; Bethlehem, PA). All participants tested negative, and after receiving these results, those who met basic eligibility criteria based on their online surveys were then provided with more information about the study. Informed consent was then acquired from those interested in enrolling, before participants completed baseline assessments. Participants were randomly assigned to receive either (1) standard post-test counseling (SPC) (control), or (2) SPC plus the GP app using a simple random assignment procedure. Those in the control condition received HIV testing, SPC and referrals only. Standard counseling adopted a person-centered approach commonly used in clinic-based settings [56]. This approach involves discussing participants' patterns of risk and key obstacles to safer behavior, before offering tailored options for reducing risk. Those in the GP condition first received HIV testing, post-test counseling and referrals, but then were provided with a tablet computer (iPad Air) and allowed to use the GP app for as long as they wished. On average, participants used GP for 33 min (range 23–39 min). Neither participants nor research staff were blind to condition.

After the session was complete, all intervention and control participants were then sent a link to complete an online survey via email every 30 days for the next 3 months. Reminder emails were sent each day for 5 days until it was completed. If the surveys were not completed within 5 days of their due date, research staff followed up with participants over the phone and helped to troubleshoot issues. Participants were paid $60 for completing their in-person appointments, and $30 for each monthly assessment they completed, with a bonus of $50 for completing all assessments, for a total of $200. Payments were issued in cash or on reloadable debit cards within 24 h of completing study procedures. The use of convenient online surveys, together with issuing substantial bonuses for completing all study procedures, were intended to ensure high response rates. All procedures were approved by the Brown University Institutional Review Board, and this study was registered on ClinicalTrials.gov (NCT03435783).

Game Plan App

Game Plan provides basic feedback and normative comparisons about users' risk for HIV (based on their recent sexual behavior) and alcohol use, similar to many existing web-based personalized feedback interventions. However, GP also goes beyond these interventions by incorporating reflective exercises similar to those often used in MI sessions that are intended to elicit "change talk." These exercises were designed to be similar to the thought exercises commonly used to develop discrepancy between current and desired behavior, such as the "looking forward/looking back" exercise [64], values card sort [65], and pros/cons "decisional balance" [38]. GP also incorporates a substantive change planning component. This section presents users with a set of change goals that are color-coded based on their potential for reducing risk, with those reducing risk the most presented first (e.g., get on PrEP, use condoms with all partners, stop drinking entirely, reduce how much [they are drinking]). Once a

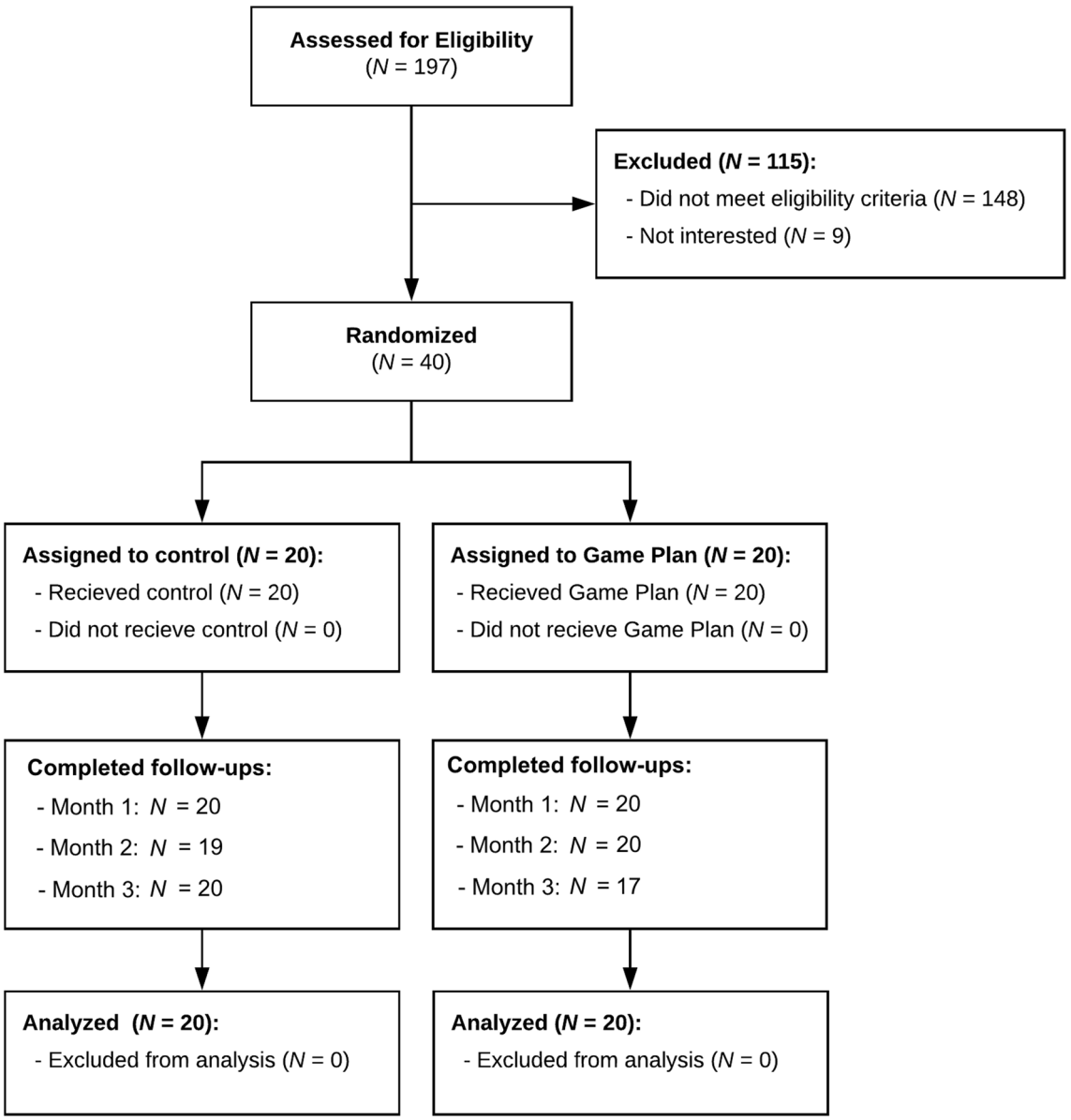

Fig. 1 CONSORT diagram of pilot study

goal is chosen, users can select from a number of specific steps tailored to their personal barriers, as well as details about who else can help them and when they will start. These goals are then added to a change plan with information about local resources (e.g., PrEP clinics, STD testing, LGBT-friendly alcohol/drug treatment), which they can then print or email to themselves. All content is tailored to users' current motivation to change each behavior, and "planting a seed" sections are available for those especially resistant to change.

Measures

In-App Data

Participants' responses to content within the app (e.g., change goals selected) were collected and exported using the app's database. Participants' motivation to change to reduce their risk for HIV and alcohol use were assessed before and after receiving feedback for each section (sex risk, alcohol), and was assessed on a 1 (*not at all*) to 8 (*extremely*) scale

reflecting the extent to which they were interested in making a change to be safer (sexually) or to drink less. We also collected data about participants' goal choices in the change planning section, including (1) whether or not they elected to set any goal to change each behavior and (2) the type of goal they set.

Alcohol Use and Sexual Behavior

Daily drinking and sexual behavior were assessed at baseline and over the three-month study period using an online Timeline Followback [66–70]. In this survey, participants were first presented with a calendar of the last 30 days, and asked to note any days on which they drank or engaged in oral, anal, or vaginal sex. Details about the behaviors on each day were then assessed using a "detail view." For alcohol use, participants reported the number of standard drinks they consumed each day they drank (with a visual key provided) and the number of hours over which they drank. For sexual behavior, participants reported the number of partners they had that day (up to 4), and for each partner, their gender, whether it was a new partner, someone they were in a sexually exclusive relationship with, whether they had ever asked about their HIV status prior to having sex with this partner, and if so, what their status was. They also reported which sex acts they engaged in with each partner (oral, insertive/receptive anal sex, vaginal sex) and whether they used a condom for each act. From this data, we generated the number of total drinks, drinking days, binge drinking (5 + drinks) days, and the average number of drinks on drinking days across each 30-day period to serve as primary drinking outcomes. High-risk CAS events were those that involved CAS with partners who (1) were new/casual, or (2) whose HIV status was unknown, either because participants had never asked, or reported that they did not know. Number of CAS events in the past 30 days was the primary sexual behavior outcome.

Alcohol-Related Problems

The number of alcohol-related problems participants reported over the last 30 days was assessed using the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ; 70) as a secondary outcome. The B-YAACQ assesses 24 consequences of alcohol consumption, each rated either *no* (0) or *yes* (1). Example items include "I have passed out from drinking," and "While drinking, I have said or done foolish things." The B-YAACQ has shown excellent psychometric properties in longitudinal studies [71].

PrEP Consultation and Uptake

Monthly surveys assessed whether participants had (1) consulted with a medical provider (e.g., doctor, nurse, or other prescriber) about starting PrEP over the past month, and (2) had received a prescription for PrEP in the past 30 days. These variables were coded to reflect as a secondary outcome whether participants had consulted about or started PrEP at any time across the 3-month study period.

Analyses

To explore GP's effects on alcohol and sexual risk outcomes after testing compared to SPC alone, we estimated several Generalized Estimating Equations (GEEs). Given that most outcomes were count in nature (e.g., number of binge drinking days, number of new partners, number of CAS events), Poisson distributions and log-link functions were specified. Each model controlled for month (represented as a dummy-coded categorical variable), the respective dependent variable at baseline, and included a dummy variable reflecting condition assignment with the control group as the reference. All analyses were conducted in intent-to-treat fashion using all available data [72]. As such, we assumed that participants had not consulted with a provider or been prescribed PrEP in a given month, for example, when data were missing for that month. Although we used these models to explore between-group differences using conventional values of statistical significance ($\alpha = 0.05$), given the exploratory nature of this study, we also interpreted the size and direction of effects in all models.

Results

Attrition and Missing Data

Of the 40 participants originally recruited, only one stopped responding to monthly surveys prior to month three, for an overall dropout rate of 2.5%. The overall response rate to monthly surveys was 97.5%, with only four total monthly surveys missing. This provided a total of 156 non-missing person-months of data. At baseline, participants randomly assigned to the GP condition drank less frequently ($\chi^2[1] = 4.99$, $p = 0.026$), but had more anal sex partners ($\chi^2[1] = 5.85$, $p = 0.016$) than did control participants. However, the two conditions did not significantly differ on any other primary outcome. See Table 1 for demographic characteristics by study condition.

Table 1 Demographic and behavioral characteristics of the study sample (N = 40)

Characteristics	Control (*N* = 20) *N* (%)	Game plan (*N* = 20) *N* (%)	χ^2 or *F*[a]
Age (range 18–53, *M* ± SD)[b]	27.7 (8.3)	28.8 (9.9)	0.4
Race			
White	13 (65.0)	15 (75.0)	0.1
Black or African American	4 (20.0)	1 (5.0)	
Asian	0 (0.0)	2 (10.0)	
Multiracial	3 (15.0)	2 (10.0)	
Ethnicity (Hispanic or Latino)	1 (5.0)	3 (15.0)	1.7
Currently in exclusive relationship[c]	0 (0.0)	1 (5.0)	1.2
Low income[d]	6 (30.0)	4 (20.0)	0.1
No college degree	12 (60.0)	6 (30.0)	2.2
Unemployed	4 (20.0)	2 (10.0)	0.5
Identity other than gay or bisexual	3 (15.0)	1 (5.0)	1.9
Days since last CAS[b]	47.2 (18.9)	47.5 (23.1)	0.1
Years since most recent HIV test[b]	0.6 (0.7)	2.3 (6.1)	1.2
AUDIT[e] ≥ 8	13 (65.0)	14 (70.0)	1.2

[a]All $p > 0.05$

[b]Shown in *M* and *SD*

[c]Represents participants who reported currently being in a sexually exclusive, monogamous relationship with one partner

[d]Represents those with a household annual income < $30,000/year

[e]Alcohol use disorders identification test

In-App Responses

On average, participants' in-app responses about their motivation to start making sexual choices increased 9.0% (*SD* 12.6%) after viewing their HIV risk feedback and completing "reflective activities" designed to develop discrepancy. Similarly, participants' motivation to make changes to their drinking increase an average of 6% (*SD* 19.6%) after viewing their alcohol feedback. However, 85% of those in the GP condition elected to set a goal to reduce their sexual risk in the change planning section, and 75% chose goals capable of reducing risk considerably (e.g., consulting with medical providers about PrEP, using condoms with all partners, using condoms with new/casual partners). Similarly, 80% of these non-treatment-seeking, heavy-drinking MSM also elected to set a goal to change their drinking, with 70% overall choosing to reduce "how much [they were] drinking." See Table 2.

Alcohol Use

Alcohol use outcomes are depicted in Fig. 2. In the GEE model of the number of drinking days (see Table 3), the overall effect of condition was significant, and suggested that those in the GP condition drank approximately 27% fewer days than those in the control condition across the follow-up period. Planned contrasts comparing the conditions within each month of follow-up showed that these between-group differences were also statistically significant across each month of follow-up. A similar model of total binge drinking days also showed that while the overall effect of intervention condition did not reach statistical significance

Table 2 Top change plan goals selected by participants assigned to use game plan (N = 20)

Goals[a]	%
Sexual risk reduction	
Take a once-daily pill called "pre-exposure prophylaxis" or "PrEP"	30.0
Use condoms with all my partners	30.0
Have anal sex with only one partner, someone I know well	25.0
Use condoms with any new or casual partners	40.0
Ask my partners about the last time they were tested	5.0
Make sure I get tested for HIV and other STDs more regularly	5.0
Meet fewer partners on "hookup" apps or websites	5.0
Only "top" with partners I don't know that well	5.0
Prepare better (e.g., use plenty of lube) when "bottoming"	10.0
Alcohol use	
Stop drinking altogether	0.0
Reduce or "cut down" on how much I'm drinking	70.0
Change how I'm drinking to keep bad things from happening as often	10.0

Users could select multiple change goals

[a]Goals are listed in the order they were presented within the app, which also reflected how much each goal could reduce risk

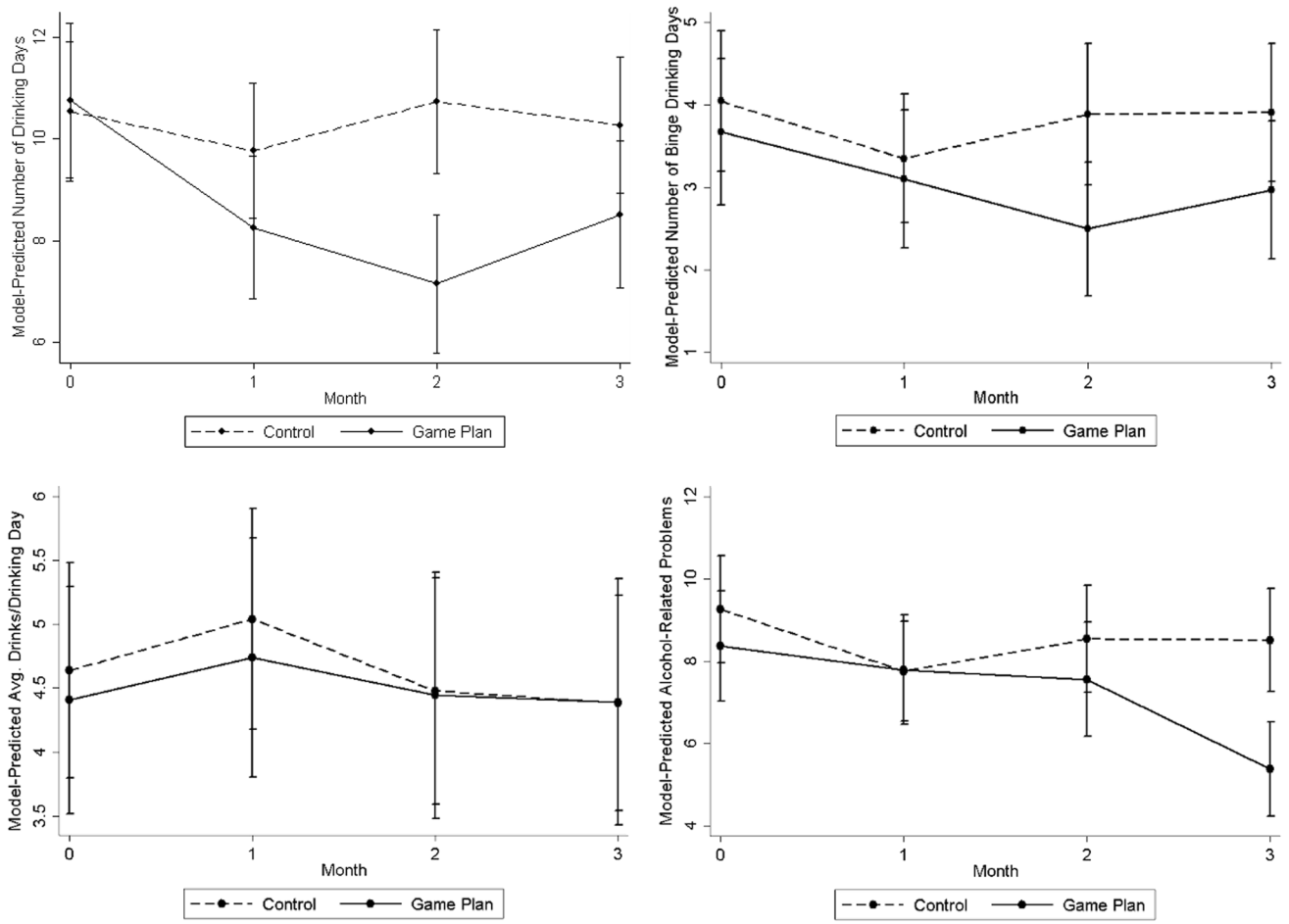

Fig. 2 Between-group differences in the number of drinking days (top left), binge drinking days (top right), average number of drinks per drinking day (bottom left) and alcohol-related problems (bottom right) across 3 months of follow-up

Table 3 GEE models of between-group differences in past 30-day alcohol outcomes across the 3-month study period

Variable	Total drinking days			Total binge drinking days			Average drinks/drinking day			Alcohol-related problems		
	IRR	*p*	95% CI	IRR	*p*	95% CI	IRR	*p*	95% CI	IRR	*p*	95% CI
Behavior at baseline[a]	1.05	< 0.001	1.04–107	1.14	< 0.001	1.09–1.19	1.09	0.002	1.03–1.15	1.01	0.081	0.99–1.03
Time	1.02	0.504	0.97–1.06	1.04	0.429	0.94–1.15	0.95	0.225	0.87–1.03	0.95	0.117	0.89–1.01
Intervention condition	0.73	**0.002**	0.61–0.89	0.76	0.051	0.48–1.01	0.97	0.777	0.77–1.21	0.83	**0.047**	0.68–0.99
Within-month contrasts												
Month 1	0.82	**0.017**	0.70–0.97	1.03	0.861	0.71–1.50	1.01	0.948	0.72–1.42	1.12	0.406	0.86–1.45
Month 2	0.65	**< 0.001**	0.54–0.76	0.68	**0.047**	0.46–0.99	1.06	0.753	0.74–1.50	0.96	0.762	0.74–1.25
Month 3	0.81	**0.009**	0.69–0.95	0.86	0.412	0.59–1.24	1.08	0.674	0.76–1.53	0.71	**0.017**	0.54–0.94

Bolded *p* values reflect $p < 0.05$

[a]Term represents participants' baseline values of each outcome

($p = 0.051$), those in the GP condition reported 24% fewer binge drinking days than control condition participants across the follow-up period. Planned contrasts suggested that while GP participants reported fewer binge drinking days than control participants across all months, this difference was only statistically significant in month 2. Models of the average number of drinks participants consumed per drinking day showed no differences between GP and control

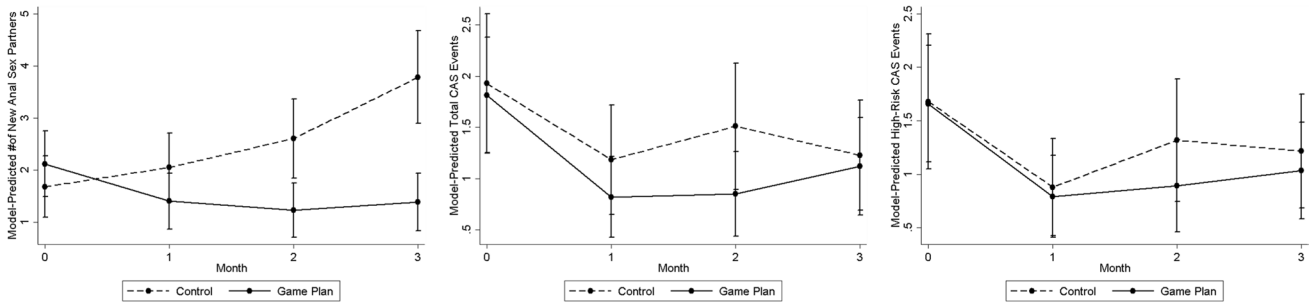

Fig. 3 Between-group differences in the number of new anal sex partners (left), total CAS events (center) and total high-risk CAS events (right) across 3 months of follow-up

participants. Finally, in GEE models of alcohol-related problems, the overall effect of intervention condition was significant, and showed that GP participants reported 17% fewer alcohol-related problems than control participants across the follow-up period. Planned contrasts showed that these between-group differences were statistically significant specifically in months 2 and 3.

Condom Use and PrEP Uptake

Sexual risk behavior outcomes are depicted in Fig. 3. Models of the total number of new anal sex partners showed that a significant between-group difference between the intervention conditions, and suggested that although GP participants reported a greater number of anal sex partners at baseline, they reported 50% fewer new partners than control participants over the course of the follow-up period when controlling for number of partners at baseline (see Table 4). Planned contrasts comparing the conditions within each month of follow-up showed significant between-group differences in months 2 and 3. However, in models of both the number of CAS events participants had with *any* partner and CAS events specifically with casual/unknown HIV status partners, the effect of intervention condition was not significant, and the effect sizes were small or nil. Finally, 40% of GP participants ($n=8$) reported having consulted with a medical provider about starting PrEP over the three-month study period, versus 30% of control participants ($n=6$). However, 15% of those in the control condition ($n=3$) actually received a PrEP prescription during the three-month follow-up period, versus 5% of GP participants ($n=1$).

Discussion

In this preliminary study, we tested whether using GP after receiving HIV testing and SPC reduced alcohol use and sexual risk behavior among high-risk, heavy drinking MSM over 3 months of follow-up, compared to post-test counseling alone. Overall, this preliminary study produced mixed

Table 4 GEE models of between-group differences in past 30-day sexual risk outcomes across the 3-month study period

Variable	Total # of new anal sex partners			Total CAS events			Total high-risk CAS[a] events		
	IRR	*p*	95% CI	IRR	*p*	95% CI	IRR	*p*	95% CI
Behavior at baseline[b]	1.11	0.003	1.04–1.19	1.17	< 0.001	1.08–1.26	1.15	0.002	1.05–1.25
Time	1.23	0.003	1.07–1.40	1.08	0.380	0.91–1.29	1.15	0.126	0.96–1.37
Intervention condition	0.50	**< 0.001**	0.35–0.72	0.88	0.619	0.54–1.44	1.00	0.989	0.60–1.68
Within-month contrasts									
Month 1	0.55	**0.040**	0.31–0.97	0.73	0.341	0.38–1.39	0.93	0.833	0.46–1.86
Month 2	0.37	**0.001**	0.21–0.67	0.60	0.114	0.32–1.13	0.69	0.255	0.36–1.31
Month 3	0.29	**< 0.001**	0.17–0.51	0.96	0.905	0.52–1.77	0.88	0.280	0.47–1.64

Bolded *p* values reflect $p < 0.05$

[a]High-risk CAS events were those that involved CAS with partners who (1) were new/casual, or (2) whose HIV status was unknown, either because participants had not ever asked before, or reported that they did not know

[b]Term represents participants' baseline values of each outcome

findings. GP participants reported significantly fewer drinking days and fewer binge drinking days across the 3-month follow-up period compared to controls. GP participants also reported significantly fewer alcohol-related problems than controls, and these differences appeared stronger in the later months of the follow-up period. This pattern of results is consistent with some other studies testing of brief alcohol interventions among MSM, which show that the effects of these interventions on drinking outcomes may strengthen over time [34]. Contrary to our hypotheses, however, GP participants did not consume fewer drinks when they drank than controls. Still, that those in the GP condition exhibited improvement across three of the four alcohol-related outcomes examined is consistent with past exploratory studies of personalized feedback for alcohol use among MSM [73], and provides considerable optimism about the potential web-based versions of these interventions have for reducing alcohol use among heavy drinking, HIV-negative MSM. The study demonstrates the potential for conducting alcohol intervention opportunistically in the context of HIV testing.

Support for GP's effects on sexual health outcomes was less clear. Despite having slightly more new anal sex partners at baseline, GP participants reported substantially fewer such partners across the post-intervention follow-up period compared to controls. Given that a quarter of GP participants selected "having sex with only one partner at a time, someone [they] knew well" as a change goal, this could reflect their success toward initiating that change. Participants in both groups reported a reduction in the number of any CAS events over the follow-up period relative to baseline, and although this difference was not statistically significant, GP participants reported a 12% greater reduction in these events than controls, providing some evidence of benefit. Similarly, both groups showed a comparable reduction in the number of CAS events with casual/unknown HIV status partners during the follow-up relative to baseline, and the effect size for between-group differences was close to zero across the follow-up period, suggesting that GP had little effect on this outcome. Finally, although there was some evidence that GP may have prompted more high-risk MSM to consult with a medical provider about starting PrEP, more participants in the control condition reported actually having started PrEP over the course of the three-month follow-up period, providing mixed results about GP's potential to help connect these men with PrEP.

These results show that the size of GP's effects varied across outcome, but the overall direction and pattern of effects are consistent with some benefit for both alcohol use and sexual risk reduction. Although one cannot establish efficacy in a preliminary study like this, GP participants generally reduced all outcome behaviors after using the app when compared to baseline and appeared to mostly fare as well or better than controls (although not always significantly so). Given that delivering such a brief intervention in HIV/STI testing clinics would be inexpensive and unburdensome to both to testing providers and to patients themselves, future research on GP could involve conducting preliminary research on implementation approaches, in addition to more rigorous tests of efficacy.

Limitations

The biggest limitation of this study was its small sample size ($N=40$). Although this sample size is consistent with a Stage 1b pilot randomized controlled trial [74], a larger sample would have allowed more confident conclusions about GP's potential for helping high-risk, heavy drinking MSM reduce their alcohol use and risk for HIV. Similarly, the study's relatively short follow-up period prevented us from exploring the durability of GP's effects on outcomes. Relying solely on self-report to assess the study's primary outcomes may also have been a limitation. Although past studies largely support the accuracy of self-reported alcohol use and sexual risk behavior when appropriately assessed [75–78], collecting clinically-relevant biomarkers of these behaviors, such as bacterial STIs and phosphatidylethanol (PEth, a biomarker of alcohol use; [79, 80]), could provide a stronger test of the intervention's potential to improve health outcomes. Next, our comparison of those who received SPC alone to those who received post-test counseling plus GP meant that control participants received an "active" intervention (i.e., one that addressed sexual risk behavior, which the intervention also addressed) and that GP participants received "more" of an intervention than controls; our goal was primarily to explore whether using GP could provide additional benefits for behavior change beyond standard practice. Current CDC guidelines suggest that those providing HIV testing also offer risk reduction counseling after testing, but do not mandate that patients receive it in order to get tested to avoid it serving as a barrier to testing [81]. However, GP was not intended to replace post-test counseling in these clinics, but to serve as either a compliment to it or another option for those uninterested in meeting with a counselor. As such, we believe that these conditions appropriately reflect how GP might be most often used in community HIV test clinics. Finally, GP was specifically developed to address sexual health among heavy drinking, high-risk MSM. Given that both the intervention content and this study focused specifically on this population, these results may not generalize to other groups.

In summary, findings from this initial study of GP's effects provide considerable optimism about its potential to help heavy drinking, high-risk MSM reduce their drinking. Its potential to help reduce HIV-risk behavior was less clear, but those who used GP still showed meaningful reductions in key outcomes (e.g., number of new sex partners,

condomless sex overall). Given the strong association that is consistently observed between heavy drinking and sexual risk behavior in across populations (including MSM; 18, 19, 22, 23) and robust evidence that alcohol interventions reduce risk behavior [82], further and more rigorous testing is clearly warranted.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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