# Acceptability and feasibility of a mobile behavioral economic health intervention to reduce alcohol use in adults in rural areas

Natalie D. Bayrakdarian [a], Erin E. Bonar [a,b,c], Isabelle Duguid [a], Lauren Hellman [a], Sarah Salino [a], Chelsea Wilkins [a], Mary Jannausch [a], James R. McKay [d,e], Michele Staton [f], Katherine Dollard [g], Inbal Nahum-Shani [h], Maureen A. Walton [a,b,c], Frederic C. Blow [a], Lara N. Coughlin [a,b,c,*]

[a] Addiction Center, Department of Psychiatry, University of Michigan, Ann Arbor, MI, United States
[b] Injury Prevention Center, University of Michigan, Ann Arbor, MI, United States
[c] Michigan Innovations in Addiction Care through Research & Education, University of Michigan, Ann Arbor, MI, United States
[d] University of Pennsylvania, Philadelphia, PA, United States
[e] Crescenz Veterans Affairs Medical Center, Philadelphia, PA, United States
[f] Department of Behavioral Science, University of Kentucky, Lexington, KY, United States
[g] MyMichigan Health, Midland, MI, United States
[h] Institute for Social Research, University of Michigan, Ann Arbor, MI, United States

## HIGHLIGHTS

- We piloted mobile-delivered interventions to meet the needs of rural populations.
- Mobile-delivered behavioral economic interventions appear acceptable and feasible.
- Preliminary efficacy outcomes show promise in reducing alcohol use and consequences.
- Preliminary efficacy outcomes were similar across all active conditions.

## ARTICLE INFO

## ABSTRACT

Background: At-risk alcohol use is associated with increased adverse health consequences, yet is undertreated in healthcare settings. People residing in rural areas need improved access to services; however, few interventions are designed to meet the needs of rural populations. Mobile interventions can provide feasible, low-cost, and scalable means for reaching this population and improving health, and behavioral economic approaches are promising.
Methods: We conducted a pilot randomized controlled trial focused on acceptability and feasibility of a mobile behavioral economic intervention for 75 rural-residing adults with at-risk alcohol use. We recruited participants from a large healthcare system and randomized them to one of four virtually-delivered conditions reflecting behavioral economic approaches: episodic future thinking (EFT), volitional choice (VC), both EFT and VC, or enhanced usual care control (EUC). The intervention included a telephone-delivered induction session followed by two weeks of condition-consistent ecological momentary interventions (EMIs; 2x/day) and ecological momentary assessments (EMAs; 1x/day). Participants completed assessments at baseline, post-intervention, and two-month follow-up, and provided intervention feedback.
Results: All participants completed the telephone-delivered session and elected to receive EMI messages. Average completion rate of EMAs across conditions was 92.9%. Among participants in active intervention conditions, 89.3% reported the induction session was helpful and 80.0% reported it influenced their future drinking. We also report initial alcohol use outcomes.
Discussion: The behavioral economic intervention components and trial procedures evaluated here appear to be feasible and acceptable. Next steps include determination of their efficacy to reduce alcohol use and public health harms.

# 1. Introduction

Globally, 3 million deaths per year result from harmful alcohol use, accounting for 5.3% of all deaths worldwide (World Health Organization, 2022). In the United States, over 28 million adults meet criteria for past-year alcohol use disorder (AUD) (SAMHSA, 2023). At-risk alcohol use, defined as an Alcohol Use Disorder Identification Test - Consumption (AUDIT-C) score of ≥3 in females and ≥4 in males (Bradley et al., 2007; Bush et al., 1998), is associated with increased adverse health consequences such as injury, impaired driving, and developing an AUD (Grant et al., 2015; Taylor et al., 2010). At-risk alcohol use in adults is undertreated in healthcare settings (Sacks et al., 2015; Stahre et al., 2014). In particular, rural populations experience increasing disparities in alcohol-related harms, including alcohol-related mortality (Friesen et al., 2022; Spencer et al., 2020), and are less likely to receive alcohol-related care (Ali et al., 2022; Davis and O'Neill, 2022). Compared to urban centers, alcohol-related care in rural areas is less affordable (Pringle et al., 2006), of lower quality (Edmond et al., 2015), and less accessible (Cyr et al., 2019; Small et al., 2010), with very few early interventions tailored to meet the specific needs of people in rural areas.

Although there is variation in rurality, treatment that requires repeated office visits often fails to meet the needs of rural residents due to geographic distances, healthcare provider shortages, and cost (Merwin et al., 2003; Reschovsky and Staiti, 2005). However, primary care provides an excellent setting for identifying people with at-risk alcohol use and linking them to mobile health interventions, including phone, video, text message, and app-based interventions. Mobile health interventions have potential to fill the gap between prevention and tertiary care (Kaner et al., 2018; Laditka et al., 2009; Weinhold and Gurtner, 2014), and remotely-delivered care may minimize stigma-related concerns by fostering greater privacy, which is key in rural communities that hold greater concern for anonymity (Browne et al., 2016) and values around self-sufficiency (Crumb et al., 2019). Mobile health interventions provide feasible and potentially low-cost means for reaching rural adults, and may reduce practical barriers such as transportation (Benavides-Vaello et al., 2013), because 91% of rural Americans own cell phones and rates of home broadband and smartphone ownership continue to climb (Mobile Fact Sheet, 2021; Vogels, 2021). In the current study, we examine a behavioral economic intervention for rural at-risk alcohol use developed using the multi-phased optimization strategy (MOST) (Collins, 2018), with a focus on establishing initial feasibility and acceptability of the intervention and randomized trial procedures. Additionally, we report on initial efficacy outcomes (i.e., preliminary intervention outcomes via alcohol use measures).

## 1.1. Behavioral economic approaches

Grounded in behavioral economic theory (Bickel et al., 2011, 2014, 2016), the current intervention components focus on increasing engagement in alternative activities without alcohol or with less alcohol (Moody et al., 2018; Murphy et al., 2012, 2019) and shifting thinking toward positive future events (Athamneh et al., 2022; Snider et al., 2016). Increasing engagement in alternative activities decreases demand for alcohol and increases reinforcement (time x enjoyment) from alcohol-free activities, whereas increasing future orientation decreases in-the-moment alcohol demand and discounting of future rewards (Meshesha et al., 2020; Snider et al., 2016). Targeting real-time alternative behaviors to alcohol use and increased focus on future goals and events hold promise for reducing alcohol use through behavioral economic mechanisms (reducing alcohol demand, increasing alcohol-free activity reinforcement, reducing delay discounting) (Bickel et al., 2014). Yet, rural populations are rarely represented in prior work (Meshesha et al., 2020; Murphy et al., 2019), which focuses largely on college students and people residing in urban centers.

## 1.2. Multi-phased Optimization Strategy guidelines

This study is guided by the Multi-phased Optimization Strategy (MOST) (Collins, 2018), an engineering-inspired framework that provides a process for optimizing multicomponent behavioral interventions, including three phases: *preparation* (pilot or feasibility trials to test intervention components), *optimization* (effectiveness of intervention components tested with considerations for affordability, scalability, and efficiency), and *evaluation* (optimized intervention tested against a suitable control). Our current work is situated in the preparation phase, focusing on the refinement, feasibility, and acceptability of treatment components within the target population.

## 1.3. Present study

Herein, we use a participant-centered approach to refine two behavioral economic intervention components to enhance fit for people in rural areas with at-risk alcohol use. The intervention components are: volitional choice (VC), which involves replacing a potentially risky health behavior with an alternative via creation of "if-then" plans (Armitage and Arden, 2012; Moody et al., 2018), and episodic future thinking (EFT), which involves envisioning future personal experiences in vivid detail (Brown and Stein, 2022). We conducted a pilot randomized controlled factorial trial to assess acceptability and feasibility of the intervention components and trial design.

# 2. Methods

This project received Institutional Review Board approval and is registered in clinicaltrials.gov (NCT05235971).

## 2.1. Preparatory refinement of the intervention components and research procedures

In preparation for the pilot study, we developed the two intervention components (EFT and VC) and study procedures, including assessments, before conducting two waves (wave 1: *n*=6, wave 2: *n*=9; May to December 2021) of beta testing with the target population (i.e., rural adults with at-risk alcohol use) to refine intervention components and research procedures. For details see Supplementary Materials. Refinements included: changing telephone-delivered surveys to online surveys to reduce burden, increasing intervention induction session prompts to maintain novelty, and adding example prompts from rural adults to enhance population-specific relevance (Fig. 1).

## 2.2. Setting, population, and recruitment

Study personnel reviewed Electronic Health Records (EHRs) of potentially eligible participants seen in primary care settings of a large academic healthcare system who met preliminary screening criteria: (1) adults aged 18 and older with a primary care appointment within the past two years, and (2) home address zip code in a rural-designated area. All participants lived in rural-designated areas, with 72 in Rural-Urban Commuting Area (RUCA) areas (Category E; RUCA, n.d.), and the remaining three participants residing in CMS Rural Health Areas (Rural Health Clinics Center, n.d.).

Identified potentially eligible participants were recruited remotely by telephone, text message, and email to screen for eligibility, including: (1) AUDIT-C score of ≥3 in females or ≥4 in males (Bradley et al., 2007; Bush et al., 1998), and (2) regular access to internet-enabled device (e.g., smartphone, computer, tablet). Study exclusion criteria was defined as: (1) does not understand English, (2) currently pregnant, (3) unable to provide informed consent due to medical/psychiatric reasons, and/or (4) current treatment for a substance use disorder. Participant recruitment led by part-time staff occurred May 2022 through April 2023.

## 2.3. Study protocol

Participant involvement lasted approximately two months, including: (1) a baseline telephone-delivered Timeline Follow-Back (TLFB) and online assessment (remunerated $30); (2) a telephone-delivered session: intervention induction (i.e., collaborative intervention content development session) for active conditions and resource brochure review for enhanced usual care (EUC; $30); (3) a two-week ecological momentary intervention (EMI) period (2x/day, sent four hours apart, for all active condition participants) and ecological momentary assessments (EMAs; 1x/day at participant's preferred time, sent with the first EMI of the day; $3/EMA); (4) a post-intervention telephone-delivered TLFB, feedback interview, acceptability survey, and online assessment ($35); and (5) a two-month follow-up telephone-delivered TLFB and online assessment ($40). See Fig. 2. Participants received a $25 bonus for at least 90% completion of all surveys (total possible: $202). Remuneration was delivered via electronic gift cards (e.g., Amazon).

## 2.4. Measures

### 2.4.1. Baseline, post-intervention, and two-month follow-up assessments

At baseline, participants completed a brief demographics questionnaire (e.g., age, sex, gender identity, race) (Tsogia et al., 2001). In addition, participants completed a *Rural Identity Scale* (15 items) (Oser et al., 2022) to understand unique experiences of rural living (e.g., rural life experiences, historical ties to community). Response options ranged from none of the time (1) to all of the time (4) with higher scores indicating greater rural identity.

#### 2.4.1.1. Alcohol-related measures.
The *AUDIT* (10-item) was modified to measure past 30-day alcohol use severity (Babor et al., n.d.; Saunders et al., 1993). Total scores ranged from 0 to 40, where scores from 0 to 7 indicate abstinence or low-risk drinking, 8–15 indicate moderate alcohol use considered greater than "low risk," 16–19 indicate harmful and potentially hazardous alcohol use, and 20–40 indicate potential alcohol use disorder.

*30-day TLFB interviews* (Sobell et al., 1996; Sobell and Sobell, 1992) assessing alcohol use quantity and frequency were conducted at baseline, post-intervention, and two-month follow-up. Proportion of days of alcohol use and average number of drinks per week were computed.

The *Modified Short Inventory of Problems - Revised* (17-item) (Kiluk et al., 2013) assessed perceived consequences of alcohol use over the past two weeks. Response options ranged from not at all (0) to very much (3) and were summed. Higher scores indicated greater consequences.

#### 2.4.1.2. Behavioral economic indices.
The *Modified Activity Level Questionnaire* assessed engagement in, and enjoyment of, alcohol-free activities and activities while consuming or under the influence of alcohol over the past 30 days (Carvalho et al., 2011; Murphy et al., 2019). Response options ranged from zero times (0) to more than once a day (4) for engagement and from unpleasant or neutral (0) to extremely pleasant (4) for enjoyment of activities.

The *Alcohol Purchase Task* assessed alcohol demand (Amlung et al., 2012). Participants indicated how many standard alcoholic drinks they would purchase and consume in a single day at varied prices (range: $0-$160).

*Delay discounting* was measured using an adjusting amount procedure where participants chose between smaller immediate and larger delayed rewards of $1,000 at a variety of delays (one day, one week, one month, three months, one year, five years, 25 years) (McKerchar and Renda, 2012). See Supplemental Materials for details on behavioral economic indices.
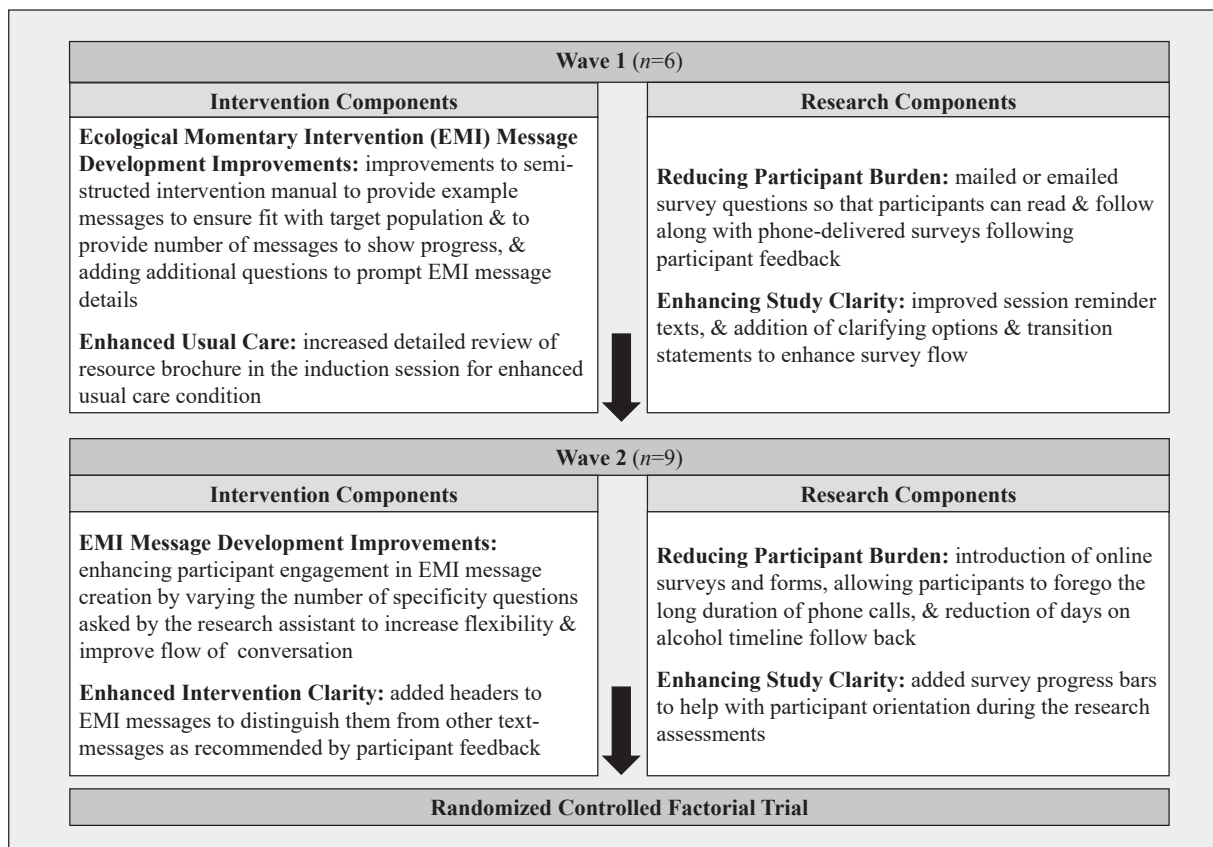


| Wave 1 (*n*=6) | |
|---|---|
| **Intervention Components** | **Research Components** |
| **Ecological Momentary Intervention (EMI) Message Development Improvements:** improvements to semi-structured intervention manual to provide example messages to ensure fit with target population & to provide number of messages to show progress, & adding additional questions to prompt EMI message details<br><br>**Enhanced Usual Care:** increased detailed review of resource brochure in the induction session for enhanced usual care condition | **Reducing Participant Burden:** mailed or emailed survey questions so that participants can read & follow along with phone-delivered surveys following participant feedback<br><br>**Enhancing Study Clarity:** improved session reminder texts, & addition of clarifying options & transition statements to enhance survey flow |

| Wave 2 (*n*=9) | |
|---|---|
| **Intervention Components** | **Research Components** |
| **EMI Message Development Improvements:** enhancing participant engagement in EMI message creation by varying the number of specificity questions asked by the research assistant to increase flexibility & improve flow of conversation<br><br>**Enhanced Intervention Clarity:** added headers to EMI messages to distinguish them from other text-messages as recommended by participant feedback | **Reducing Participant Burden:** introduction of online surveys and forms, allowing participants to forego the long duration of phone calls, & reduction of days on alcohol timeline follow back<br><br>**Enhancing Study Clarity:** added survey progress bars to help with participant orientation during the research assessments |

| Randomized Controlled Factorial Trial |
|---|

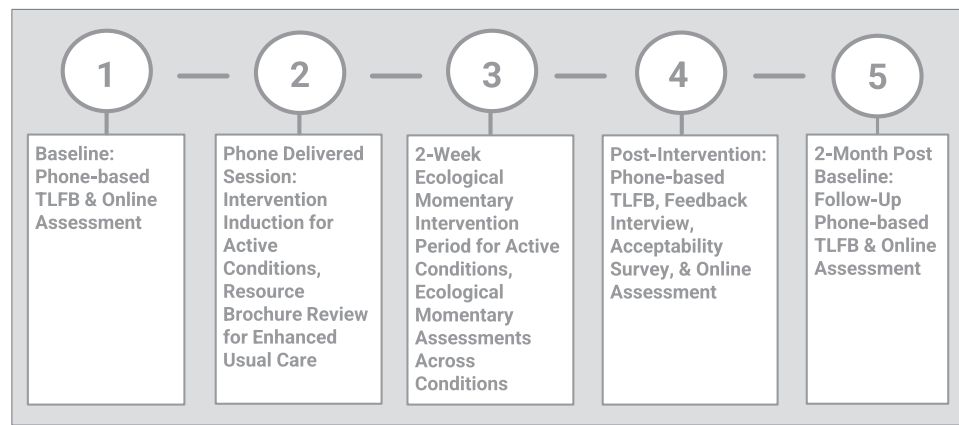**Fig. 1.** Participatory-based refinements to intervention and research components.

**Fig. 2.** Overview of study procedures.

### 2.4.2. EMAs

Daily EMAs included standard drinks consumed the prior day and a brief behavioral economic measure, randomized to promote novelty and minimize assessment burden, with .33 probability of: (1) a six-item delay discounting task (Koffarnus and Bickel, 2014), (2) a three-item alcohol demand assessment (Owens et al., 2015), or (3) a four-item assessment of time spent/enjoyment from alcohol-free activities and alcohol-using activities the previous day (Coughlin et al., 2023).

### 2.4.3. Acceptability and feasibility measures

Acceptability (percent of item responses with positive rating) and feasibility (percent of participants who completed the telephone-delivered session and percent who elected to receive text messages) were the prespecified registered primary outcomes. Following two-week EMI period completion (mean ($M$)=3.56, standard deviation ($SD$)=3.16 days), participants completed the acceptability survey including: intervention satisfaction, perceived effectiveness, and adequacy of compensation and privacy protection. Response options regarding intervention satisfaction (i.e., helpfulness of intervention induction session and daily personalized EMIs) and perceived effectiveness (i.e., reduction of drinking, influence on future drinking) ranged from not at all (1) to extremely (5) with higher scores indicating greater acceptability and perceived effectiveness. We dichotomized response scales such that the top four scores indicated acceptability and effectiveness (i.e., a little, somewhat, very much, or extremely). Acceptability of compensation and privacy responses ranged from not at all adequate/protected (0) to extremely adequate/protected (10), with scores of 5 or higher indicating adequate compensation and privacy protection.

In addition, participants were invited to complete an audio-recorded feedback interview during the post-intervention session. The purpose of the feedback interview was to provide a nuanced understanding of participants' perceived strengths and areas for improvement of the intervention and trial procedures. The interview included open-ended questions, such as, "What suggestions do you have to improve the study or to make participation more enjoyable for future participants?"

### 2.5. Randomization procedure

As done previously (Koffarnus et al., 2018, 2021), participants were randomly assigned to one of four conditions: (1) EFT ($n$=17); (2) VC ($n$=21); (3) EFT/VC ($n$=19); or (4) EUC ($n$=18), with an even allocation ratio between groups. The randomization procedure used a computerized algorithm that biased condition assignment to balance the groups based on AUDIT-C score, biological sex, and age.

### 2.6. Behavioral economic intervention components

### 2.6.1. Telephone-delivered intervention induction session

Active participants completed a telephone-delivered intervention induction session ($M$=48, $SD$=16 minutes) with a trained research staff member supervised by a licensed PhD-level practitioner. Sessions were recorded and a fidelity checklist (e.g., number of cues and prompts, nonjudgmental communication) was completed by another trained staff member. For the active conditions (EFT, VC, and EFT/VC), this session focused on developing personalized cues, which were short EFT or VC intervention statements in the words of the participant, for later delivery via EMI. Participants were requested to write each cue on study-provided adhesive notepads to place in participant-identified locations (e.g., bathroom mirror, planner, refrigerator) that they would see during daily life.

*2.6.1.1. EFT condition.* In the EFT condition, participants identified future events at six time points (one, two, three, and six months, one year, and five years). Via phone call, participants were instructed that chosen events should be something they are looking forward to or a positive experience and that no events should include drinking alcohol or other substance use. For each time point, participants identified one event. Participants were encouraged to close their eyes to visualize the event with queries to elicit details (e.g., What do your surroundings look like?). Participants summarized each event into a brief statement/cue that was used for the EMIs (e.g., "In two months from now, I'll be preparing for gardening, buying seeds, and making plans for the summer growing season").

*2.6.1.2. VC condition.* Participants in the VC condition were guided through creating six "if-then" plans/cues as alternatives to drinking, such as "If [I had] a hard day at work, then I will go out to my workshop and work on cars because it is a total mental reset." Participants were prompted to identify common triggers for alcohol use in their day-to-day life, and then to identify alternative activities. Similar to EFT, participants were queried to elicit details (e.g., What can you do to give yourself the best shot at trying [the alternative behavior]?).

*2.6.1.3. EFT/VC condition.* Participants in the combined EFT and VC condition constructed 12 statements in total (six EFT, six VC), with identical procedures to those reported in *2.6.1.1* and *2.6.1.2*.

*2.6.1.4. EUC control condition.* For the EUC condition, the telephone-delivered session consisted of an in-depth review of a resource brochure mailed to all participants ($M$=6, $SD$=1.5 minutes). The brochure included content on mental health, alcohol and other substance use, housing and hunger support, etc.

### 2.6.2. EMI period

Directly following the telephone-delivered session, participants in active conditions began the two-week EMI period, during which they received their personalized EMI text messages twice daily. EMI text messages contained the personalized cues developed in the induction session, stating: "Remember: [personalized cue]." EMI order was randomly assigned, without repetition within the same day to minimize redundancies.

### 2.7. Analytic strategy

The primary outcomes of this pilot study are acceptability and feasibility of the intervention. We summarized participant characteristics descriptively, including demographics, rurality, clinical features,
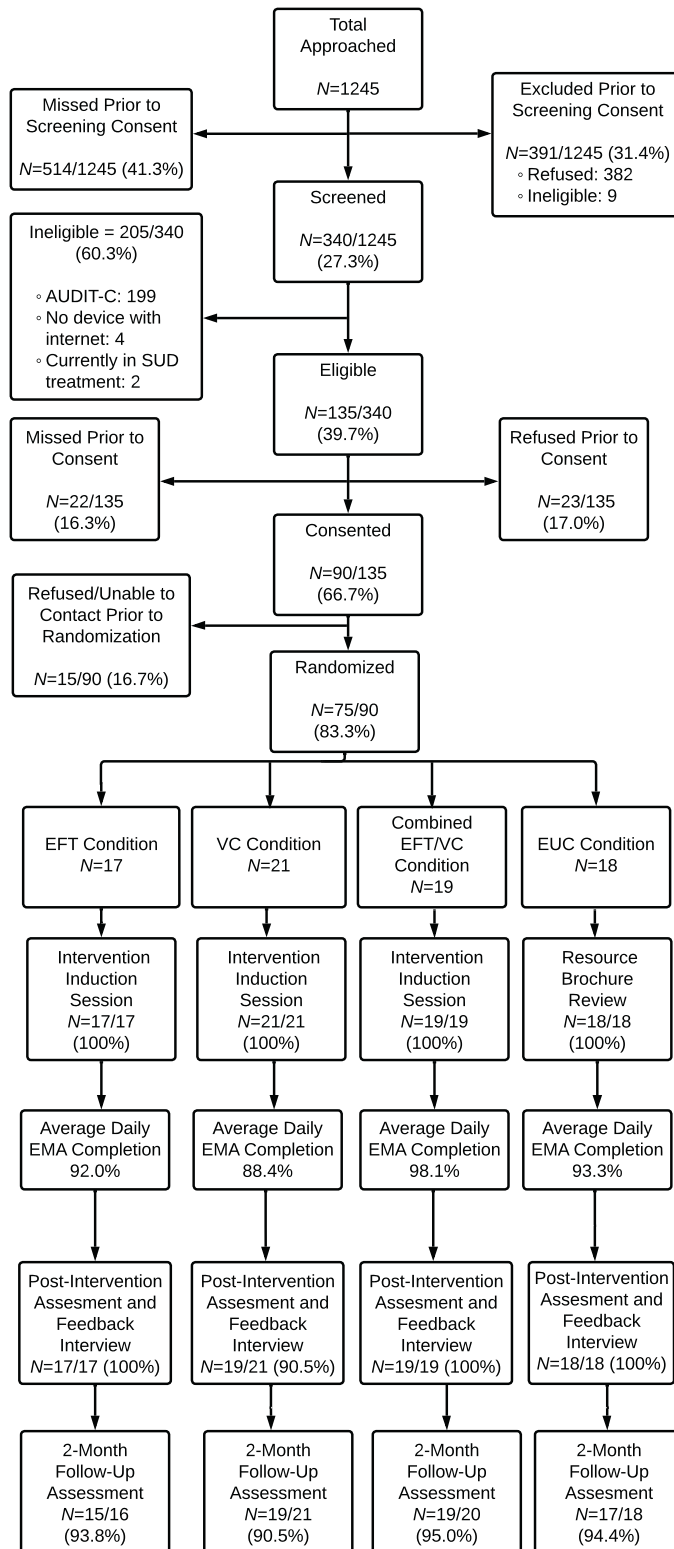


**Fig. 3.** Consort diagram.

and acceptability measures. Feasibility of the intervention was evaluated by percent intervention induction session completion, percent electing to receive text messages, and percent EMA completion. As an exploratory outcome, we assessed baseline to post-intervention, and baseline to two-month follow-up change (*M, SD*) in alcohol-related outcomes (e.g., AUDIT, average weekly drinks). With regard to behavioral economic indices, we assessed the association with alcohol-related outcomes via Pearson Fisher's *Z* correlations.

We used rapid qualitative analysis (Gale et al., 2019; Hamilton and Finley, 2019; Nevedal et al., 2021) to identify key themes from feedback interviews. Following each interview, the interviewer listened to the recording and completed a structured summary to capture participant-identified strengths, suggestions for improvement, and illustrative quotes. After all interviews were completed, five interviews from each of the four conditions were selected at random to undergo rapid qualitative analysis, as sample sizes of approximately twenty are recommended for assessing usability with high accuracy (Faulkner, 2003). The information and key quotes from summaries were coded into a matrix based on domains defined to reflect the interview questions, such as strengths, opportunities for improvement, and perspectives on remote delivery. Repeating key themes and exemplar quotes were extracted.

## 3. Results

### 3.1. Sample characteristics

In total, 340 people screened, with 39.7% eligible. Among those eligible, 66.7% consented and 83.3% of those consenting completed the baseline assessment and were randomized. Nearly all (97.3%) participants completed the post-intervention acceptability survey, feedback interview, TLFB, and online assessment, and 93.3% completed the two-month follow-up (Fig. 3).

Of those enrolled, 62.7% identified as female sex; mean age was 55.2 years (*SD*=15.9). The mean AUDIT-C score was 5.0 (*SD*=2.3; Table 1).

### 3.2. Feasibility and acceptability of intervention and trial

Intervention feasibility, pre-specified as percent of randomized participants who completed the telephone-based session, was 100%. All participants in active conditions elected to receive EMIs. Participants had high EMA completion: 92.0% in EFT, 88.4% in VC, 98.1% in combined EFT/VC, and 93.3% in EUC.

With regard to acceptability, 98.6% of participants reported enjoying participating in the trial, and 86.3.% said they would recommend the study (Table 2 for by condition acceptability ratings). In active conditions, most found the telephone-delivered induction session to be at least a little helpful, most found the EMI text messages to be helpful, and most reported that the study influenced their future drinking behaviors. Nearly all participants reported adequate compensation and adequate privacy during the study (Table 2).

### 3.3. Alcohol-related outcomes and behavioral economic correlates

Descriptively, at post-intervention, VC consistently showed reductions across measures of alcohol use severity, frequency, quantity, and consequences; whereas the other conditions showed more variable descriptive changes from baseline. At follow-up, AUDIT scores decreased across all active conditions. There was no change in AUDIT scores in EUC. Frequency of alcohol use decreased across all conditions at two-month follow-up. Quantity of alcohol use decreased across all active conditions, and slightly increased in EUC. Alcohol use consequences decreased across all active conditions, and increased in EUC (Table 3).

Factor analysis of the alcohol purchase task resulted in two factors representing alcohol demand amplitude and persistence (see

**Table 1**

Demographics of the study sample by randomization group and overall.

| | Overall | Condition | | | |
|---|---|---|---|---|---|
| | | EFT | VC | EFT/VC | EUC |
| N (%) | 75 (100%)* | 17 (23%) | 21 (28%) | 19 (25%) | 18 (24%) |
| **Demographics** | | | | | |
| Age (*M, SD*) | 55.2 (15.9) | 54.0 (19.8) | 54.7 (13.4) | 58.0 (14.8) | 53.9 (16.5) |
| Sex | | | | | |
|   Male | 28 (37%) | 7 (41%) | 8 (38%) | 7 (37%) | 6 (33%) |
|   Female | 47 (63%) | 10 (59%) | 13 (62%) | 12 (63%) | 12 (67%) |
| Gender Identity | | | | | |
|   Male | 28 (37%) | 7 (41%) | 8 (38%) | 7 (37%) | 6 (33%) |
|   Female | 45 (60%) | 10 (59%) | 12 (57%) | 12 (63%) | 11 (61%) |
|   Another Gender Identity** | 2 (3%) | 0 (0%) | 1 (5%) | 0 (0%) | 1 (6%) |
| Hispanic/Latinx | | | | | |
|   Yes | 5 (7%) | 1 (6%) | 0 (%) | 1 (5%) | 3 (17%) |
|   No | 70 (93%) | 16 (94%) | 21 (100%) | 18 (95%) | 15 (83%) |
| Race/Ethnicity | | | | | |
|   American Indian/Alaskan Native | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
|   Asian | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
|   Native Hawaiian or other Pacific Islander | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
|   Black/African American | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
|   White | 74 (99%) | 17 (100%) | 21 (100%) | 19 (100%) | 17 (94%) |
|   More than one race | 1 (1%) | 0 (0%) | 0 (0%) | 0 (0%) | 1 (6%) |
|   Don't know/ Refuse | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |
| Income | | | | | |
|   Under $15,000 | 8 (11%) | 2 (12%) | 3 (14%) | 2 (10%) | 1 (5%) |
|   $15,000-$24,999 | 7 (9%) | 2 (12%) | 0 (0%) | 1 (5%) | 4 (22%) |
|   $25,000-$34,999 | 7 (9%) | 0 (0%) | 5 (24%) | 1 (5%) | 1 (5%) |
|   $35,000-$49,999 | 11 (15%) | 1 (8%) | 2 (15%) | 5 (33%) | 3 (25%) |
|   $50,000-$74,999 | 16 (22%) | 4 (33%) | 5 (38%) | 5 (33%) | 2 (17%) |
|   $75,000-$99,999 | 6 (8%) | 2 (17%) | 1 (8%) | 1 (7%) | 2 (17%) |
|   $100,000 and over | 19 (26%) | 5 (42%) | 5 (38%) | 4 (27%) | 5 (42%) |
| Rurality | | | | | |
| Rural Identity Scale | 28.8 (6.3) | 30.0 (5.4) | 28.4 (5.3) | 27.4 (5.7) | 29.7 (8.6) |
| RUCA Rural Designated Areas | | | | | |
|   Large rural cities and towns | 46 (61.3%) | 6 (35.3%) | 15 (71.4%) | 11 (57.9%) | 14 (77.8%) |
|   Small rural towns | 22 (29.3%) | 9 (52.9%) | 5 (23.8%) | 7 (36.8%) | 1 (5.6%) |
|   Isolated small rural towns | 4 (5.3%) | 2 (11.8%) | 1 (4.8%) | 0 (0%) | 1 (5.6%) |
| CMS Rural Health Designated Areas | 3 (4.0%) | 0 (0%) | 0 (0%) | 1 (5.3%) | 2 (11.1%) |
| **Substance Use & Mental Health** | | | | | |
| Alcohol Use Severity (AUDIT) (*M, SD*) | 7.9 (6.8) | 7.2 (5.7) | 7.5 (6.8) | 8.4 (8.0) | 8.6 (6.8) |
| Alcohol Use Consumption (AUDIT-C) (*M, SD*) | 5.0 (2.3) | 4.7 (1.6) | 4.9 (2.2) | 5.2 (2.7) | 5.1 (2.5) |

**Table 1** (*continued*)

| | Overall | Condition | | | |
|---|---|---|---|---|---|
| | | EFT | VC | EFT/VC | EUC |
| Depression (PHQ-2) (*M*, *SD*) | 1.2 (1.6) | 1.1 (1.9) | 1.0 (1.0) | 1.6 (2.1) | 0.9 (1.4) |
| Anxiety (GAD-2) (*M*, *SD*) | 1.5 (1.7) | 1.4 (1.5) | 1.6 (1.8) | 1.8 (2.2) | 1.2 (1.1) |
| Past-Year Substance Use (DUQ) | 48 (64.9%) | 13 (81.2%) | 16 (76.2%) | 11 (57.9%) | 8 (44.4%) |
| **Baseline Behavioral Economic Indices** | | | | | |
| Behavioral Economic Alcohol Demand | | | | | |
| Amplitude | >0.0001 (1.0) | 0.099 (0.935) | -0.159 (0.912) | 0.034 (1.042) | 0.066 (1.219) |
| Persistence | >0.0001 (1.0) | -0.082 (1.190) | -0.007 (1.118) | 0.005 (0.825) | 0.104 (0.873) |
| Delay Discounting | | | | | |
| ln(k) | -7.294 (1.818) | -7.492 (1.291) | -7.386 (2.171) | -6.886 (1.184) | -7.415 (2.447) |
| Relative Reinforcement | | | | | |
| Proportion Substance Free Reinforcement | 72.4% (21.6%) | 70.2% (16.5%) | 76.7% (23.1%) | 72.7% (19.9%) | 68.8% (25.9%) |
| Proportion Substance Involved Reinforcement | 27.6% (21.6%) | 29.8% (16.5%) | 23.3% (23.1%) | 27.3% (19.9%) | 31.2% (25.9%) |

\**n*=1 enrollee provided no baseline data beyond age, sex, gender identity, race, and rurality.

\*\*This category includes gender identities such as transgender, genderqueer, non-binary, etc.

Supplemental Materials). Across all conditions, demand amplitude, but not persistence, showed medium to large positive correlation with alcohol use quantity, severity, and consequences; but only small correlations with frequency, at all time points (baseline, post-intervention, follow-up). Proportionate alcohol-free reinforcement showed medium to large negative correlations with alcohol use quantity, severity, consequences, and frequency across time points (Table 4).

*3.4. Feedback interview*

Participants in active conditions liked that the intervention was person-centered, easy to engage in, and increased their awareness of drinking behaviors (Table 5 for illustrative quotes). Some noted that receiving the intervention remotely reduced barriers related to in-person healthcare in rural areas.

Participants in active conditions suggested improvements regarding increased flexibility of personalized cue development, such as providing prompts ahead of the session to allow more time for preparation. Others noted that individual characteristics (e.g., older age, caretaker status) made the induction session more challenging. Participants also had suggestions regarding the timing of EMIs (e.g., receiving texts in the evenings, randomizing the time of the second EMI to promote novelty) and ideas for additional services that would be of benefit, including those focusing on mental health, additional health behaviors (e.g., food, diet, exercise, sleep), and a greater focus on other substance use (e.g., cannabis). Participants expressed an interest in additional information about alcohol use motives and risks associated with alcohol use. With regard to research components, participants suggested increasing the novelty of EMAs (i.e., more than three behavioral economic measures to reduce repetitiveness).

**Table 2**
Acceptability of intervention and trial procedures.

| | Overall | Condition | | | |
|---|---|---|---|---|---|
| | | EFT | VC | EFT/VC | EUC |
| **Intervention Satisfaction** | % or *M* (*SD*) | | | | |
| Enjoyed participating (scale 0–5) | | | | | |
| Extremely | 12 (16.4%) | 2 (11.8%) | 3 (15.8%) | 4 (21.0%) | 3 (16.7%) |
| Very Much | 33 (45.2%) | 11 (64.7%) | 10 (52.6%) | 6 (31.6%) | 6 (33.3%) |
| Somewhat | 24 (32.9%) | 3 (17.6%) | 5 (26.3%) | 8 (42.1%) | 8 (44.4%) |
| A Little | 3 (4.1%) | 1 (5.9%) | 1 (5.3%) | 1 (5.3%) | 0 (0.0%) |
| Not at all | 1 (1.4%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 1 (5.6%) |
| Likelihood of recommending to someone else (scale 0–10, % who said 5 or above) | 63 (86.3%) | 16 (94.1%) | 17 (89.5%) | 17 (89.5%) | 13 (72.2%) |
| Likelihood of recommending to someone else (scale 0–10) | 7.3 (2.7) | 7.9 (2.4) | 6.9 (2.5) | 7.7 (2.1) | 6.7 (3.7) |
| Ease of responding to daily text messages (Pretty Easy to Very Easy) | 71 (97.3%) | 15 (88.2%) | 15 (88.2%) | 15 (88.2%) | 15 (88.2%) |
| **Perceived Effectiveness of Intervention** (scale 0–5) | | | | | |
| Helpfulness of Intervention Induction Session\* | | | | | |
| Extremely | 3 (5.4%) | 0 (0%) | 0 (0%) | 3 (15.8%) | |
| Very Much | 10 (18.2%) | 4 (23.5%) | 5 (26.3%) | 1 (5.3%) | |
| Somewhat | 25 (45.4%) | 8 (47.1%) | 8 (42.1%) | 9 (47.4%) | |
| A Little | 11 (20.0%) | 3 (17.6%) | 4 (21.0%) | 4 (21.0%) | |
| Not at all | 6 (10.9%) | 2 (11.8%) | 2 (10.5%) | 2 (10.5%) | |
| Helpfulness of EMIs\* | | | | | |
| Extremely | 4 (7.3%) | 1 (5.9%) | 0 (0.0%) | 3 (15.8%) | |
| Very Much | 17 (30.9%) | 7 (41.2%) | 6 (31.6%) | 4 (21.0%) | |
| Somewhat | 20 (36.4%) | 7 (41.2%) | 6 (31.6%) | 7 (36.8%) | |
| A Little | 8 (14.5%) | 1 (5.9%) | 5 (26.3%) | 2 (10.5%) | |
| Not at all | 6 (10.9%) | 1 (5.9%) | 2 (10.5%) | 3 (15.8%) | |
| Influenced future drinking behaviors | | | | | |
| Extremely | 1 (1.4%) | 0 (0%) | 0 (0%) | 0 (0%) | 1 (5.6%) |
| Very Much | 15 (20.5%) | 5 (29.4%) | 5 (26.3%) | 4 (21.0%) | 1 (5.6%) |
| Somewhat | 18 (24.7%) | 4 (23.5%) | 6 (31.6%) | 7 (36.8%) | 1 (5.6%) |
| A Little | 17 (23.3%) | 3 (17.6%) | 5 (26.3%) | 5 (26.3%) | 4 (22.2%) |
| Not at all | 22 (30.1%) | 5 (29.4%) | 3 (15.8%) | 3 (15.8%) | 11 (61.1%) |

**Table 2** (*continued*)

| | Overall | Condition | | | |
|---|---|---|---|---|---|
| | | EFT | VC | EFT/VC | EUC |
| **Compensation & Privacy Acceptability** (scale 0–10) | *n* (%) | | | | |
| Adequacy of compensation (rated 5 or higher) | 71 (98.6%) | 16 (100.0%) | 19 (100.0%) | 19 (100.0%) | 17 (94.4%) |
| Usefulness of compensation (rated 5 or higher) | 72 (100%) | 17 (100.0%) | 19 (100.0%) | 18 (94.7%) | 18 (100.0%) |
| Adequacy of privacy protection (rated 5 or higher) | 71 (97.3%) | 17 (100.0%) | 19 (100.0%) | 18 (94.7%) | 17 (94.4%) |

*These items were only asked to participants in active conditions.

## 4. Discussion

This pilot trial tested the feasibility and acceptability of a novel, multicomponent behavioral economic intervention for rural-dwelling adults with at-risk alcohol use. The ultimate goal is to develop and evaluate an effective, scalable, and appealing intervention for this population. In this preliminary work, participants were satisfied with the intervention's ease of engagement and person-centeredness. Many participants provided feedback that their participation increased their awareness of their alcohol consumption. Additionally, the vast majority of participants reported that they enjoyed participating; and most found the telephone-delivered session and EMIs (for those in active conditions) helpful. The study procedures were feasible, with >90% completion rate across assessments (e.g., EMAs, post-intervention, follow-up).

We also note a few key strengths. First, primary care patients residing in rural areas were identified based on their EHR, contacted, enrolled, and participated entirely remotely. This method for engaging people with at-risk alcohol use is scalable and may serve as a model for care outreach to better meet the needs of people with at-risk alcohol use. Second, participants reported liking the low-burden nature of the intervention, with a single telephone-based intervention induction session followed by text message-based EMIs. This combination of talking

with a staff member, followed by digital intervention delivery of personalized cues, may strike a balance between expensive person-based services and more scalable digital interventions. In particular, the inclusion of non-clinician interviewers demonstrates the potential for using peer recovery specialists or other staff, potentially paraprofessionals or bachelor's level staff, in the delivery of these interventions, increasing potential for scalability. Third, intervention development was guided by the MOST framework, using two theory-driven behavioral economic intervention components, and refined with individuals from the population. This provides a rigorous model for developing interventions with high probability of meeting the lofty goal of being effective, appealing to the target population, and adequately scalable to have an impactful reach.

No definitive conclusions can be drawn from behavioral outcomes since pilot studies are not powered to test efficacy (Kraemer et al., 2006; Leon et al., 2011) and are most helpful in informing procedures for future work. Thus, statistical testing is not appropriate. Nonetheless, these pilot findings are promising with regard to potential reductions in alcohol use, with all active conditions showing reduction in alcohol use severity, frequency, quantity, and consequences at follow-up; whereas, EUC showed increases in alcohol use quantity and consequences, no change in severity, and minimal decreases in frequency at follow-up (Table 3). Notably, the outcomes in the combined EFT/VC condition were comparable to the EFT and VC alone conditions. One possible explanation for this is that the combined condition included the same dose of EMIs such that across all active conditions, each participant received two EMIs per day for a total of 28 EMIs throughout the intervention period. It may be the case that by increasing the number of EMIs, we would see increased effects in the combined EFT/VC condition. Interestingly, the improvements across alcohol use measures in the VC condition appear more pronounced post-intervention, but the EFT condition shows the greatest reductions in alcohol use severity, quantity, and consequences at follow-up. Although preliminary and not evaluated statistically, the case may be that the VC condition, which focuses more on immediate behavior change, results in more near-term alcohol use reduction; whereas the EFT condition, which focuses on envisioning future alcohol-free events and goals, is more effective at changing long-term alcohol use. However, replication is required in a fully-powered trial with longer follow-up periods given the pilot nature of this study.

As an exploratory outcome, we looked at the association between behavioral economic indices (alcohol demand, proportionate alcohol-

**Table 3**
Preliminary intervention outcomes.

| | Baseline (N = 74) M (SD) | Post-Intervention (N = 73) M (SD) | % Change Baseline to Post-Intervention | 2-Month Follow-up (N = 70) M (SD) | % Change Baseline to 2-Month |
|---|---|---|---|---|---|
| **Alcohol Use Severity (AUDIT)** | | | | | |
| EFT | 7.2 (5.7) | 6.5 (4.8) | -9.7% | 4.5 (2.5) | -37.5% |
| VC | 7.5 (6.8) | 6.2 (5.8) | -17.3% | 5.9 (5.8) | -21.3% |
| EFT/VC | 8.4 (8.0) | 7.1 (8.2) | -15.5% | 6.4 (7.7) | -23.8% |
| EUC | 8.6 (6.8) | 7.3 (5.6) | -15.1% | 8.6 (8.9) | 0.0% |
| **Frequency (Proportion of Days of Alcohol Use)** | | | | | |
| EFT | 0.49 (0.28) | 0.49 (0.30) | 0.0% | 0.38 (0.29) | -22.4% |
| VC | 0.53 (0.34) | 0.50 (0.33) | -5.7% | 0.39 (0.28) | -26.4% |
| EFT/VC | 0.47 (0.32) | 0.43 (0.34) | -8.5% | 0.40 (0.34) | -14.9% |
| EUC | 0.56 (0.36) | 0.52 (0.41) | -7.1% | 0.55 (0.39) | -1.8% |
| **Quantity (Avg # of Weekly Drinks Consumed)** | | | | | |
| EFT | 10.3 (10.5) | 9.7 (10.2) | -5.8% | 6.1 (4.8) | -40.8% |
| VC | 12.4 (13.2) | 8.8 (7.5) | -29.0% | 8.0 (11.1) | -35.5% |
| EFT/VC | 14.8 (24.1) | 13.2 (24.1) | -10.8% | 13.2 (24.3) | -10.8% |
| EUC | 14.0 (13.4) | 11.6 (11.0) | -17.1% | 14.9 (17.2) | 6.4% |
| **Consequences (SIP-R Total Score)** | | | | | |
| EFT | 4.9 (8.9) | 5.2 (7.0) | 6.1% | 2.4 (2.8) | -51.0% |
| VC | 5.5 (8.6) | 3.9 (6.0) | -29.1% | 4.0 (7.5) | -27.3% |
| EFT/VC | 5.4 (8.5) | 5.8 (9.4) | 9.3% | 4.9 (10.3) | -9.3% |
| EUC | 4.6 (8.4) | 4.4 (6.0) | -4.3% | 5.9 (10.1) | 28.3% |

**Table 4**

Select baseline behavioral economic indices correlations with alcohol use measures across timepoints.**

| | Baseline | Post-Intervention | 2-Month Follow-Up |
|---|---|---|---|
| | *r* (95% CI) | *r* (95% CI) | *r* (95% CI) |
| **Demand Amplitude** | | | |
| Quantity of Alcohol Use (Average Weekly Drinks) | **0.54 (0.35, 0.70)** | **0.46 (0.23, 0.64)** | **0.48 (0.26, 0.65)** |
| Alcohol Use Severity (AUDIT) | **0.63 (0.46, 0.76)** | **0.59 (0.39, 0.73)** | **0.53 (0.32, 0.69)** |
| Alcohol Related Consequences (SIP-R) | **0.51 (0.30, 0.67)** | **0.48 (0.26, 0.66)** | **0.46 (0.24, 0.64)** |
| Alcohol Use Frequency (proportion of days alcohol use) | 0.03 (-0.21, 0.27) | 0.09 (-0.17, 0.33) | 0.13 (−0.13, 0.37) |
| **Demand Persistence** | | | |
| Quantity of Alcohol Use (Average Weekly Drinks) | -0.02 (-0.26, 0.22) | -0.07 (-0.32, 0.19) | 0.04 (-0.21, 0.29) |
| Alcohol Use Severity (AUDIT) | -0.01 (-0.25, 0.23) | -0.13 (-0.38, 0.13) | 0.01 (-0.24, 0.27) |
| Alcohol Related Consequences (SIP-R) | -0.07 (-0.31, 0.17) | -0.14 (-0.38, 0.12) | 0.05 (-0.20, 0.30) |
| Alcohol Use Frequency (proportion of days alcohol use) | 0.10 (-0.15, 0.33) | -0.02 (-0.28, 0.23) | 0.15 (-0.11, 0.38) |
| **Proportion Alcohol-Free Reinforcement** | | | |
| Quantity of Alcohol Use (Average Weekly Drinks) | **-0.32 (-0.51, −0.09)** | **-0.35 (-0.54, −0.13)** | **-0.43 (−0.61, −0.22)** |
| Alcohol Use Severity (AUDIT) | **-0.35 (-0.54, −0.13)** | **-0.50 (-0.65, −0.30)** | **-0.52 (-0.67, −0.32)** |
| Alcohol Related Consequences (SIP-R) | **-0.31 (-0.51, −0.09)** | **-0.43 (-0.60, −0.22)** | **-0.39 (-0.57, −0.17)** |
| Alcohol Use Frequency (proportion of days alcohol use) | **-0.41 (-0.59, −0.20)** | **-0.34 (-0.53, −0.12)** | **-0.57 (-0.71, −0.38)** |
| **Delay Discounting (ln k)** | | | |
| Quantity of Alcohol Use (Average Weekly Drinks) | 0.09 (-0.16, 0.34) | 0.24 (-0.001, 0.46) | 0.03 (-0.22, 0.28) |
| Alcohol Use Severity (AUDIT) | 0.18 (-0.08, 0.42) | 0.22 (-0.03, 0.44) | -0.04 (-0.29, 0.21) |
| Alcohol Related Consequences (SIP-R) | 0.15 (-0.11, 0.39) | 0.24 (-0.001, 0.46) | -0.08 (-0.32, 0.18) |
| Alcohol Use Frequency (proportion of days alcohol use) | -0.005 (0.26, 0.25) | 0.06 (-0.19, 0.30) | -0.01 (-0.26, 0.24) |

\* Across all conditions.

\** Correlations in BOLD were significant at 0.01 or less.

**Table 5**

Key themes from feedback interviews with participants receiving active intervention conditions.

| Themes | Exemplar Quotes | Condition |
|---|---|---|
| **Intervention Strengths** | | |
| Ease of Engagement | *"It didn't interfere with my daily work or anything like that, it was pretty painless."* | VC |
| | *"It wasn't intrusive, so it really didn't bother me that much. I didn't feel like I was being pressured or anything."* | EFT |
| Increased Awareness of Drinking | *"I enjoyed recognizing my drinking habits and talking about them because I think that a lot of times, I can make healthier choices in certain situations or limit the amount of intake that I do, and this has made me more cognizant of that, so that was my favorite thing about the study."* | EFT/VC |
| | *"One of the features was just being aware of how much you drink and what it relates to and so that's good, just awareness and acknowledgement of drinking and when you do it."* | EFT |
| Person Centered Intervention | *"I liked my input. That it was an interactive where there was guidance, but it was also very personalized based on my habits and the things that I do."* | VC |
| | *"They were my own suggestions, and they just were reminding me of what I said might be a good idea as far as finding alternatives to alcohol use which is always a good thing to be reminded of."* | EFT/VC |
| | *"Looking into the future was helpful too, thinking about how your alcohol use today is going to affect you in the future."* | EFT |
| Remote Intervention for Rural Populations | *"The remote option would be very useful to those in the rural community."* | VC |
| | *"I think that you let the user choose the medium, whether it was telephone or text or email, so that was very convenient and that was most helpful."* | VC |
| **Intervention Improvements** | | |
| Increase Flexibility in EMI development | | |
| Prior Time to Consider Prompts | *"I don't know if it's possible to send an email or a form that could be done at your leisure with more time to think about it- I think that would be more effective in getting scenarios that feel more authentic."* | EFT/VC |
| Consideration of Age & Lifestyle | *"I guess not go 5 years in the future, for me at least in my age, but other than that it was fine, it was good."* | EFT |
| | *"For me, being 77 and kind of isolated where I am, not around family, friends, parties, it is much different than somebody who's maybe 32 that works every day and has friends and has parties and goes out after work. I know I'm much different now than I was at that age."* | EFT/VC |
| EMI Timing | *"I think getting the text messages later in the day because I don't start drinking until later in the day."* | EFT/VC |
| | *"I do think that maybe randomizing communication times would probably be helpful so that way you're not expecting it at a certain time so it kind of catches you off guard sometimes, I think that's actually a good thing."* | EFT |

free reinforcement, delay discounting) (Bickel et al., 2014; Coughlin et al., 2021) with alcohol-related outcomes over time. We saw that behavioral economic demand amplitude and proportionate alcohol-free activities showed consistent associations across most alcohol outcomes. In particular, the proportion of alcohol-free activities showed promise as a candidate predictor of alcohol-related outcomes, especially as it relates to increased improvement in clinical outcomes. Notably, increasing alcohol-free reinforcement is a primary goal of other efficacious treatments such as the Community Reinforcement Approach (Miller et al., 1999).

This work should be considered in light of limitations. This is a pilot study focused on evaluating the acceptability and feasibility of the intervention and research design. Consistent with recommendations for pilot studies (Leon et al., 2011), caution should be used in the interpretation of clinical outcomes and candidate behavioral economic mechanisms. Second, the sample was predominantly white, consistent with population in rural Michigan (Citizens Research Council of Michigan, 2018), but limiting generalizability of the sample. Further, the representativeness of the sample and generalizability are limited due to the small sample in this pilot study. Finally, the study used retrospective self-report of alcohol use. However, we used the TLFB which is a valid measure (Simons et al., 2015).

Nonetheless, these novel intervention components offer promising approaches to reduce alcohol use among people living in rural areas, with strong grounding in behavioral economics. Future work is needed to establish if these interventions alone, or in combination with others, promote successful behavior change by continuing to follow the MOST guidelines for intervention optimization.

## Funding

## Author contributions

Only the authors listed are responsible for the content and preparation of this manuscript. LNC led development of the research idea. NDB, ID, and LNC prepared the manuscript, MJ lead analyses, and all authors provided feedback during the preparation process. All authors have approved of this manuscript.

## CRediT authorship contribution statement

**Inbal Nahum-Shani:** Writing – review & editing, Conceptualization. **Maureen A. Walton:** Writing – review & editing, Conceptualization. **Natalie D. Bayrakdarian:** Writing – review & editing, Writing – original draft, Visualization, Project administration. **Katherine Dollard:** Writing – review & editing. **James R. McKay:** Writing – review & editing, Conceptualization. **Michele Staton:** Writing – review & editing, Conceptualization. **Chelsea Wilkins:** Writing – review & editing, Supervision, Project administration. **Mary Jannausch:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Lauren Hellman:** Writing – review & editing, Project administration. **Sarah Salino:** Writing – review & editing, Project administration. **Frederic C. Blow:** Writing – review & editing, Funding acquisition, Conceptualization. **Erin E. Bonar:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **Lara N. Coughlin:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Isabelle Duguid:** Writing – review & editing, Writing – original draft, Project administration, Conceptualization.

## Declaration of Competing Interest

The authors of this paper have no conflicts of interest to declare.

## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.dadr.2024.100225.

## References

Ali, M.M., Nye, E., West, K., 2022. Substance use disorder treatment, perceived need for treatment, and barriers to treatment among parenting women with substance use disorder in US rural counties. J. Rural Health Off. J. Am. Rural Health Assoc. Natl. Rural Health Care Assoc. 38 (1), 70–76.

Amlung, M.T., Acker, J., Stojek, M.K., Murphy, J.G., MacKillop, J., 2012. Is talk "cheap"? An initial investigation of the equivalence of alcohol purchase task performance for hypothetical and actual rewards. Alcohol. Clin. Exp. Res. 36 (4), 716–724.

Armitage, C.J., Arden, M.A., 2012. A volitional help sheet to reduce alcohol consumption in the general population: a field experiment. Prevent. Sci. Off. J. Soc. Prev. Res. 13 (6), 635–643.

Athamneh, L.N., Brown, J., Stein, J.S., Gatchalian, K.M., LaConte, S.M., Bickel, W.K., 2022. Future thinking to decrease real-world drinking in alcohol use disorder: repairing reinforcer pathology in a randomized proof-of-concept trial. Exp. Clin. Psychopharmacol. 30 (3), 326–337.

Babor, T.F., Higgins-Biddle, J.C., Saunders, J.B., Monteiro, M.G., n.d. AUDIT: The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Health Care. https://apps.who.int/iris/bitstream/handle/10665/67205/W?sequence=1.

Benavides-Vaello, S., Strode, A., Sheeran, B.C., 2013. Using technology in the delivery of mental health and substance abuse treatment in rural communities: a review. J. Behav. Health Serv. Res. 40 (1), 111–120.

Bickel, W.K., Jarmolowicz, D.P., Mueller, E.T., Gatchalian, K.M., 2011. The behavioral economics and neuroeconomics of reinforcer pathologies: implications for etiology and treatment of addiction. Curr. Psychiatry Rep. 13 (5), 406–415.

Bickel, W.K., Johnson, M.W., Koffarnus, M.N., MacKillop, J., Murphy, J.G., 2014. The behavioral economics of substance use disorders: reinforcement pathologies and their repair. Annu. Rev. Clin. Psychol. 10, 641–677.

Bickel, W.K., Mellis, A.M., Snider, S.E., Moody, L., Stein, J.S., Quisenberry, A.J., 2016. Novel therapeutics for addiction: behavioral and neuroeconomic approaches. Curr. Treat. Options Psychiatry 3 (3), 277–292.

Bradley, K.A., DeBenedetti, A.F., Volk, R.J., 2007. AUDIT-C as a brief screen for alcohol misuse in primary care. Alcohol. Clin. Exp. Res. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1530-0277.2007.00403.x?casa_token=lCqhF8pN9OEAAAAA:_sUFDQakBOcOVakNRFrN3-rwpye0RLaXX-0zB2hGFHvZAOPdf44pMrtheN0UAePYhxbPEq4H6N76zQU.

Brown, J.M., Stein, J.S., 2022. Putting prospection into practice: Methodological considerations in the use of episodic future thinking to reduce delay discounting and maladaptive health behaviors. Front. Public Health 10, 1020171.

Browne, T., Priester, M.A., Clone, S., Iachini, A., DeHart, D., Hock, R., 2016. Barriers and facilitators to substance use treatment in the rural south: a qualitative study. J. Rural Health Off. J. Am. Rural Health Assoc. Natl. Rural Health Care Assoc. 32 (1), 92–101.

Bush, K., Kivlahan, D.R., McDonell, M.B., Fihn, S.D., Bradley, K.A., for the Ambulatory Care Quality Improvement Project (ACQUIP), 1998. The AUDIT Alcohol Consumption Questions (AUDIT-C): an effective brief screening test for problem drinking. Arch. Intern. Med. 158 (16), 1789–1795.

Carvalho, J.P., Gawrysiak, M.J., Hellmuth, J.C., McNulty, J.K., Magidson, J.F., Lejuez, C. W., Hopko, D.R., 2011. The reward probability index: design and validation of a scale measuring access to environmental reward. Behav. Ther. 42 (2), 249–262.

Citizens Research Council of Michigan, 2018. Exploring Michigan's Urban-Rural Divide. https://crcmich.org/wp-content/uploads/rpt400_Exploring_Michigans_Urban-Rural_Divide-2.pdf.

Collins, L.M., 2018. Optimization of Behavioral, Biobehavioral, and Biomedical Interventions: The Multiphase Optimization Strategy (MOST). Springer International Publishing.

Coughlin, L.N., Bonar, E.E., Bickel, W.K., 2021. Considerations for remote delivery of behavioral economic interventions for substance use disorder during COVID-19 and beyond. J. Subst. Abus. Treat. 120, 108150.

Coughlin, L.N., Bonar, E.E., Wieringa, J., Zhang, L., Rostker, M.J., Augustiniak, A.N., Goodman, G.J., Lin, L. (allison), 2023. Pilot trial of a telehealth-delivered behavioral economic intervention promoting cannabis-free activities among adults with cannabis use disorder. J. Psychiatr. Res. https://doi.org/10.1016/j.jpsychires.2023.05.012.

Crumb, L., Mingo, T.M., Crowe, A., 2019. "Get over it and move on": the impact of mental illness stigma in rural, low-income United States populations. Ment. Health Prev. 13, 143–148.

Cyr, M.E., Etchin, A.G., Guthrie, B.J., Benneyan, J.C., 2019. Access to specialty healthcare in urban versus rural US populations: a systematic literature review. BMC Health Serv. Res. 19 (1), 974.

Davis, C.N., O'Neill, S.E., 2022. Treatment of alcohol use problems among rural populations: a review of barriers and considerations for increasing access to quality care. Curr. Addict. Rep. 9 (4), 432–444.

Edmond, M.B., Aletraris, L., Roman, P.M., 2015. Rural substance use treatment centers in the United States: an assessment of treatment quality by location. Am. J. Drug Alcohol Abus. 41 (5), 449–457.

Faulkner, L., 2003. Beyond the five-user assumption: benefits of increased sample sizes in usability testing. Behav. Res. Methods Instrum. Comput. J. Psychon. Soc. Inc. 35 (3), 379–383.

Friesen, E.L., Bailey, J., Hyett, S., Sedighi, S., de Snoo, M.L., Williams, K., Barry, R., Erickson, A., Foroutan, F., Selby, P., Rosella, L., Kurdyak, P., 2022. Hazardous alcohol use and alcohol-related harm in rural and remote communities: a scoping review. Lancet Public Health 7 (2), e177–e187.

Gale, R.C., Wu, J., Erhardt, T., Bounthavong, M., Reardon, C.M., Damschroder, L.J., Midboe, A.M., 2019. Comparison of rapid vs in-depth qualitative analytic methods from a process evaluation of academic detailing in the Veterans Health Administration. Implement. Sci. 14, 11.

Grant, B.F., Goldstein, R.B., Saha, T.D., Chou, S.P., Jung, J., Zhang, H., Pickering, R.P., Ruan, W.J., Smith, S.M., Huang, B., Hasin, D.S., 2015. Epidemiology of DSM-5 alcohol use disorder: results from the national epidemiologic survey on alcohol and related conditions III. JAMA Psychiatry 72 (8), 757–766.

Hamilton, A.B., Finley, E.P., 2019. Qualitative methods in implementation research: an introduction. Psychiatry Res. 280, 112516.

Kaner, E.F., Beyer, F.R., Muirhead, C., Campbell, F., Pienaar, E.D., Bertholet, N., Daeppen, J.B., Saunders, J.B., Burnand, B., 2018. Effectiveness of brief alcohol interventions in primary care populations. Cochrane Database Syst. Rev. 2 (2), CD004148.

Kiluk, B.D., Dreifuss, J.A., Weiss, R.D., Morgenstern, J., Carroll, K.M., 2013. The Short Inventory of Problems - revised (SIP-R): psychometric properties within a large, diverse sample of substance use disorder treatment seekers. Psychol. Addict. Behav. J. Soc. Psychol. Addict. Behav. 27 (1), 307–314.

Koffarnus, M.N., Bickel, W.K., 2014. A 5-trial adjusting delay discounting task: accurate discount rates in less than one minute. Exp. Clin. Psychopharmacol. 22 (3), 222–228.

Koffarnus, M.N., Bickel, W.K., Kablinger, A.S., 2018. Remote alcohol monitoring to facilitate incentive-based treatment for alcohol use disorder: a randomized trial. Alcohol. Clin. Exp. Res. 42 (12), 2423–2431.

Koffarnus, M.N., Kablinger, A.S., Kaplan, B.A., Crill, E.M., 2021. Remotely administered incentive-based treatment for alcohol use disorder with participant-funded incentives is effective but less accessible to low-income participants. Exp. Clin. Psychopharmacol. 29 (5), 555–565.

Kraemer, H.C., Mintz, J., Noda, A., Tinklenberg, J., Yesavage, J.A., 2006. Caution regarding the use of pilot studies to guide power calculations for study proposals. Arch. Gen. Psychiatry 63 (5), 484–489.

Laditka, J.N., Laditka, S.B., Probst, J.C., 2009. Health care access in rural areas: evidence that hospitalization for ambulatory care-sensitive conditions in the United States may increase with the level of rurality. Health Place 15 (3), 731–740.

Leon, A.C., Davis, L.L., Kraemer, H.C., 2011. The role and interpretation of pilot studies in clinical research. J. Psychiatr. Res. 45 (5), 626–629.

McKerchar, T.L., Renda, C.R., 2012. Delay and probability discounting in humans: an overview. Psychol. Rec. 62 (4), 817–834.

Merwin, E., Hinton, I., Dembling, B., Stern, S., 2003. Shortages of rural mental health professionals. Arch. Psychiatr. Nurs. 17 (1), 42–51.

Meshesha, L.Z., Soltis, K.E., Wise, E.A., Rohsenow, D.J., Witkiewitz, K., Murphy, J.G., 2020. Pilot trial investigating a brief behavioral economic intervention as an adjunctive treatment for alcohol use disorder. J. Subst. Abus. Treat. 113, 108002.

Miller, W.R., Meyers, R.J., Hiller-Sturmhöfel, S., 1999. The community-reinforcement approach. Alcohol Res. Health J. Natl. Inst. Alcohol Abus. Alcohol. 23 (2), 116–121.

Mobile Fact Sheet, 2021. Pew Research Center: Internet, Science & Tech. http://www.pewinternet.org/fact-sheet/mobile/.

Moody, L.N., Tegge, A.N., Poe, L.M., Koffarnus, M.N., Bickel, W.K., 2018. To drink or to drink less? Distinguishing between effects of implementation intentions on decisions to drink and how much to drink in treatment-seeking individuals with alcohol use disorder. Addict. Behav. 83, 64–71.

Murphy, J.G., Dennhardt, A.A., Skidmore, J.R., Borsari, B., Barnett, N.P., Colby, S.M., Martens, M.P., 2012. A randomized controlled trial of a behavioral economic supplement to brief motivational interventions for college drinking. J. Consult. Clin. Psychol. 80 (5), 876–886.

Murphy, J.G., Dennhardt, A.A., Martens, M.P., Borsari, B., Witkiewitz, K., Meshesha, L.Z., 2019. A randomized clinical trial evaluating the efficacy of a brief alcohol intervention supplemented with a substance-free activity session or relaxation training. J. Consult. Clin. Psychol. 87 (7), 657–669.

Nevedal, A.L., Reardon, C.M., Opra Widerquist, M.A., Jackson, G.L., Cutrona, S.L., White, B.S., Damschroder, L.J., 2021. Rapid versus traditional qualitative analysis using the Consolidated Framework for Implementation Research (CFIR). Implement. Sci. 16 (1), 67.

Oser, C.B., Strickland, J., Batty, E.J., Pullen, E., Staton, M., 2022. The rural identity scale: development and validation. J. Rural Health Off. J. Am. Rural Health Assoc. Natl. Rural Health Care Assoc. 38 (1), 303–310.

Owens, M.M., Murphy, C.M., MacKillop, J., 2015. Initial development of a brief behavioral economic assessment of alcohol demand. Psychol. Conscious. 2 (2), 144–152.

Pringle, J.L., Emptage, N.P., Hubbard, R.L., 2006. Unmet needs for comprehensive services in outpatient addiction treatment. J. Subst. Abus. Treat. 30 (3), 183–189.

Reschovsky, J.D., Staiti, A.B., 2005. Access and quality: does rural America lag behind? Health Aff. 24 (4), 1128–1139.

RUCA, n.d. Rural Health Research Center. https://depts.washington.edu/uwruca/ruca-uses.php.

Rural Health Clinics Center, n.d. ⟨https://www.cms.gov/center/provider-type/rural-health-clinics-center⟩.

Sacks, J.J., Gonzales, K.R., Bouchery, E.E., Tomedi, L.E., Brewer, R.D., 2015. 2010 National and state costs of excessive alcohol consumption. Am. J. Prev. Med. 48 (5), e73–e79.

SAMHSA, 2023. 2021 NSDUH Detailed Tables. ⟨https://www.samhsa.gov/data/report/2021-nsduh-detailed-tables⟩.

Saunders, J.B., Aasland, O.G., Babor, T.F., de la Fuente, J.R., Grant, M., 1993. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption–II. Addiction 88 (6), 791–804.

Simons, J.S., Wills, T.A., Emery, N.N., Marks, R.M., 2015. Quantifying alcohol consumption: self-report, transdermal assessment, and prediction of dependence symptoms. Addict. Behav. 50, 205–212.

Small, J., Curran, G.M., Booth, B., 2010. Barriers and facilitators for alcohol treatment for women: are there more or less for rural women? J. Subst. Abus. Treat. 39 (1), 1–13.

Snider, S.E., LaConte, S.M., Bickel, W.K., 2016. Episodic future thinking: expansion of the temporal window in individuals with alcohol dependence. Alcohol. Clin. Exp. Res. 40 (7), 1558–1566.

Sobell, L.C., Sobell, M.B., 1992. Timeline follow-back. Measuring Alcohol Consumption. Humana Press, pp. 41–72.

Sobell, L.C., Brown, J., Leo, G.I., Sobell, M.B., 1996. The reliability of the alcohol timeline followback when administered by telephone and by computer. Drug Alcohol Depend. 42 (1), 49–54.

Spencer, M.R., Curtin, S.C., Hedegaard, H., 2020. Rates of alcohol-induced deaths among adults aged 25 and over in urban and rural areas: United States, 2000-2018. NCHS Data Brief 383, 1–8.

Stahre, M., Roeber, J., Kanny, D., Brewer, R.D., Zhang, X., 2014. Contribution of excessive alcohol consumption to deaths and years of potential life lost in the United States. Prev. Chronic Dis. 11, E109.

Taylor, B., Irving, H.M., Kanteres, F., Room, R., Borges, G., Cherpitel, C., Greenfield, T., Rehm, J., 2010. The more you drink, the harder you fall: a systematic review and meta-analysis of how acute alcohol consumption and injury or collision risk increase together. Drug Alcohol Depend. 110 (1-2), 108–116.

Tsogia, Copello, Orford, A., J., & Dorothea, 2001. Entering treatment for substance misuse: a review of the literature. J. Ment. Health 10 (5), 481–499.

Vogels, E.A., 2021. Some Digital Divides Persist between Rural, Urban and Suburban America. Pew Research Center. https://www.pewresearch.org/short-reads/2021/08/19/some-digital-divides-persist-between-rural-urban-and-suburban-america/.

Weinhold, I., Gurtner, S., 2014. Understanding shortages of sufficient health care in rural areas. Health Policy 118 (2), 201–214.

World Health Organization, 2022. https://www.who.int/news-room/fact-sheets/detail/alcohol.