HHS Public Access

Author manuscript

*Mayo Clin Proc Digit Health*. Author manuscript; available in PMC 2024 July 09.

Published in final edited form as:

*Mayo Clin Proc Digit Health*. 2024 June ; 2(2): 192–206. doi:10.1016/j.mcpdig.2024.03.004.

# Therapeutic Content of Mobile Phone Applications for Substance Use Disorders: An Umbrella Review

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## Abstract

Mobile phone applications (MPAs) for substance use disorder (SUD) treatment are increasingly used by patients. Although pilot studies have shown promising results, multiple previous systematic reviews noted insufficient evidence for MPA use in SUD treatment—many of the previously published reviews evaluated different trials. Subsequently, we aimed to conduct an umbrella review of previously published reviews investigating the efficacy of MPAs for SUD treatment, excluding nicotine/tobacco because umbrella reviews have been done in this population and the nicotine/tobacco MPA approach often differs from SUD-focused MPAs. No previous reviews have included a statistical meta-analysis of clinical trials to quantify an estimated overall effect. Seven reviews met inclusion criteria, and 17 unique studies with available data were taken from those reviews for the meta-analysis. Overall, reviews reported a lack of evidence for recommending MPAs for SUD treatment. However, MPA-delivered recovery support services, cognitive behavioral therapy, and contingency management were identified across multiple



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POTENTIAL COMPETING INTERESTS

The author reports no competing interests.

SUPPLEMENTAL ONLINE MATERIAL

Supplemental material can be found online at https://www.mcpdigitalhealth.org/. Supplemental material attached to journal articles has not been edited, and the authors take responsibility for the accuracy of all data.

reviews as having promising evidence for SUD treatment. Hedges *g* effect size for an MPA reduction in substance use—related outcomes relative to the control arm was insignificant (0.137; 95% CI, −0.056 to 0.330; *P*=.16). In subgroup analysis, contingency management (1.29; 95% CI, 1.088-1.482; $\tau^2$=0; *k*=2) and cognitive behavioral therapy (0.02; 95% CI, 0.001-0.030; $\tau^2$=0; *k*=2) were significant. Although contingency management's effect was large, both trials were small (samples of 40 and 30). This review includes an adapted framework for the American Psychiatric Association's MPA guidelines that clinicians can implement to review MPAs critically with patients.

Only 10% of people who need treatment for substance use disorders (SUDs) receive specialized care.[1] Research suggests that telehealth and digitally enabled clinical tools can remove barriers to access and significantly improve SUD treatment utilization.[2] The proliferation of cell phones worldwide has dramatically increased internet access. In 2021, 97% of Americans owned a cellphone and 85% owned a smartphone with internet capability.[3] Smartphones use mobile phone applications (MPAs) to deliver content to the user through the phone. Most cellphone users have downloaded health-related applications,[4] and individuals with an SUD have reported interest in using applications for relapse prevention.[5]

Several published reviews have examined the efficacy of MPAs in mental health conditions. A 2020 umbrella review of 7 meta-analyses concluded that applications for depression and anxiety held the best potential. However, there was wide variation in study quality and insufficient blinding, which limited the analysis of MPA efficacy.[6] Goldberg et al[7] conducted a systematic meta-review of 14 meta-analyses of randomized controlled trials (RCTs) of mobile phone—based interventions for mental health. Publication bias and small sample sizes within the meta-analyses resulted in inadequate evidence to support mobile phone —based interventions for any condition or outcome.[7] Other reviews have found mental health MPA studies consistently limited by variable outcome data and limited participant engagement.[6–8]

Nicotine dependency is the most investigated MPA clinical condition.[7] MPAs for smoking cessation tend to differ significantly from SUD MPAs. Most smoking cessation applications focus on disease education (76%) and self-tracking of use (70%).[9] Reviews of smoking cessation applications found few well-powered studies, with MPAs improving abstinence rates between 0.9% and 12% by the trial end point.[9,10] Further reviews found no evidence to support that MPAs with greater content volume improved smoking cessation outcomes compared with lower-intensity options.[11]

Data from 2018 estimated that over 900 applications were available to support recovery from substance use. New SUD applications appear daily in the Google and Apple application stores. Most commercially available MPAs for SUDs do not integrate any components of evidence-based approaches. Furthermore, many frequently downloaded applications promote unhealthy (eg, use of alternative addictive substances) or unproven interventions (ie, no research to support the assertions or approach) for recovery.[12–15] This can be confusing for patients. Subsequently, clinicians need guidelines to determine which MPAs have the best evidence for SUD treatment.

The American Psychiatric Association (APA) hosts an MPA evaluation framework on its website (https://www.psychiatry.org/psychiatrists/practice/mental-health-applications/the-application-evaluation-model). This framework can be a helpful tool to assess MPA content before a recommendation. Levels 1 and 2 represent basic usability and safety principles, level 3 emphasizes clinical foundation, level 4 focuses on engagement strategy, and level 5 evaluates therapeutic goals.[16]

## Aim

MPAs have the potential to augment traditional SUD treatment; however, guidance for clinical selection is limited. This review intends to assist providers in identifying the type of MPAs that deliver evidence-based approaches. This review differs from previous reviews in several ways. First, it incorporates all previously completed reviews in a comprehensive umbrella review; second, it provides a meta-analysis of previously conducted studies with subgroup analysis; finally, it analyzes application-specific content through the APA evaluation framework (clinical foundation, engagement, and therapeutic goals) to assist providers in providing evidence-based SUD MPA recommendations to their patients.

## METHODS

A medical librarian searched the literature for mobile applications and substance use concepts. Search strategies were created using keywords and standardized index terms (see Appendix). Searches were conducted on July 2, 2023, in EBSCO CINHAL with Full Text (1963+), Ovid Embase (1974+), Ovid Medline (1946+ including epub ahead of print, in-process, and other nonindexed citations), Ovid PsycINFO (1806+), Scopus (1788+), and Web of Science Core Collection (Science Citation Index Expanded 1975+ and Emerging Sources Citation Index 2015+).

After limiting results to reviews (study design), 2199 citations were retrieved. Deduplication occurred in Covidence, leaving 1393 citations. Articles were screened by title and abstract. Three authors (T.S.O., S.A.B., T.W.) conducted the initial review, of whom 2 (T.S.O., S.A.B.) reviewed citations at the full-text level. Uncertainty was resolved by discussion, if needed, with a third author (D.K.H.-F., D.C.F., or V.M.K.). For meta-analysis, 1 author (N.L.B.) reviewed all clinical trials within the identified reviews. Uncertainty was resolved by discussion with another author (T.S.O. and S.A.B.).

### Inclusion Criteria

Inclusion criteria were systematic reviews on MPAs for the treatment of SUDs focused on abstinence, reduction of symptoms/use, or treatment retention.

### Exclusion Criteria

Exclusion criteria were as follows: (1) studies that focused on nicotine or behavioral addictions. Nicotine-focused reviews were excluded owing to an extensive existing literature identifying nicotine/tobacco as a unique subgroup that warrants an independent umbrella review. (2) Studies not reporting outcomes of clinical interest; (3) studies focused exclusively on text messaging or computer-based modules. After screening, 101 articles

remained for full-text review. During the full-text review, we excluded articles that proved to have nonsuitable interventions (eg, computer-only modules and texting-based), nontargeted populations (eg, general mental health, no SUD, and youth), uninterested outcomes (eg, economics and nonrecovery/treatment adherence), or study design. Seven reviews remained (Table 1).[17–23] These reviews were deconstructed to identify interventions for symptom reduction/resolution and/or treatment retention. *PRISMA flow diagram* is shown in Figure 1.[24]

For the meta-analysis, a random-effects model with restricted maximum likelihood measures was chosen a priori owing to expected heterogeneity across MPAs and substances. The included studies required a control arm. Reviews identified by the parent study criteria were then investigated for eligible studies. Studies that were included in multiple reviews were only used once. We planned for subgroup analysis across MPA content; we later added an alcohol-specific subgroup because of the majority of included studies focusing on alcohol. Data were extracted from studies using a customized template. If an eligible study had missing data, the corresponding author was contacted. Measures to quantify use varied. Timeline follow-back, total drinks over a defined period, peak drinks, risky drinking, days per drinking day, and days of substance use were used across studies.

Calculations were performed in R v4.3.0 with packages dplyr, meta, and metafor, and figures were created with functions forest and funnel.[25]

## RESULTS

### Systematic Review

Seven reviews met a priori criteria (Table 1).[17–23] Bahadoor et al[17] reported that 5 of the 22 articles evaluated supported positive outcomes for SUDs, with those studies incorporating recovery support strategies (RSSs). Getty et al[18] identified 2 studies reporting positive results in alcohol-related outcomes, both using contingency management (CM).[18] Colbert et al[19] built off Bahadoor et al[17] and found that RCTs differentially supported RSSs. Horvath et al[20] evaluated 8 studies, but only 3 had usable data from small pilot studies; these studies supported RSSs and cognitive behavioral therapy (CBT). Kazemi et al[21] reviewed MPAs using RSSs, dialectical behavioral therapy, CBT, and motivational enhancement therapy (MET). They also concluded that RSS had the greatest efficacy. Manning et al[22] identified RSS as having the best evidence; however, they added that CBT and approach-based modification (ABM) modules showed promise. Staiger et al[23] identified 12 studies examining alcohol and illicit SUD application-based interventions. They also concluded that RSS offered significant benefits. Nuamah et al[26] reviewed application-based studies evaluating opioid use disorder (OUD) treatment and found that no RCTs supported their use. However, they noted reSET-O[27] was already approved for OUD treatment and had promising results.

### Meta-Analysis

Data was incorporated from 17 trials (Table 2).[28–44] The Hedges *g* effect size for all application content types in decreasing substance use was 0.137 (95% CI, —0.056 to 0.330;

$P$=.16) compared with control; $\tau^2$ was 0.164 (SE=0.066), and $I^2$ was 87.81%, indicating high heterogeneity. Figure 2 shows the forest plot. The funnel plot was overall. However, multiple studies were on the outer edge of the funnel or entirely outside of it (included in the Supplemental Material).

A subgroup analysis was conducted for application content (see further for background on each content type). Five applications used RSS, 3 used MET, 2 used CBT, 2 used CM, 1 used ABM, and 4 had unique content that did not fit within a standard therapeutic framework and was grouped as “other” (feedback/coaching-style approaches focused on either sobriety or behavioral activation). CBT and CM subgroups were significant. However, these results were from only 2 applications each; the remaining modalities were insignificant. Effect sizes and heterogeneity were as follows: RSS—Hedges $g$=−0.151 (95% CI, −0.886 to 0.585; $\tau^2$=0.700; $k$=5); MI—Hedges $g$=0.124 (95% CI, −0.201 to 0.443; $\tau^2$=0.077, $k$=3); CBT—Hedges $g$=0.015 (95% CI, 0.001-0.030; $\tau^2$=0; $k$=2); CM—Hedges $g$=1.286 (95% CI, 1.088-1.482; $k$=2); ABM—Hedges $g$=−0.113 (95% CI, −0.240 to 0.014; $k$=1); and other—Hedges $g$=0.086 (95% CI, −0.237 to 0.410; $\tau^2$=0.105; $k$=4). Subgroup analysis was also conducted on alcohol-specific articles, with Hedges $g$=0.148 (95% CI, −0.162 to 0.458; $k$=16). Although CM had a large effect size, the study samples were small. All other subgroup effect sizes were nonsignificant or below small size ($g$<0.2).

**Clinical Foundation on Strategies and Interventions for the Treatment of SUD**

**Contingency Management.—**CM is a therapeutic intervention based on principles of operant conditioning for behavior modification where monetary or prize-based reinforcers are delivered contingent on objective evidence of drug abstinence and abstinence-promoting behaviors.[45] CM does not provide education or concepts for individuals to learn; instead, it positively reinforces the desired outcome or behavior. CM has decades of research representing hundreds of RCTs demonstrating efficacy in SUD treatment.[45] Although it is a successful intervention, challenges exist for its implementation in conventional treatment programs.[46]

Traditionally, CM is delivered via inperson or group settings, where the provider awards a prize for desired behavior engagement (eg, treatment participation or attendance, medication adherence, and negative drug testing). Evidence suggests that mobile technology can achieve critical components of CM: (1) monitoring the desired behavior and (2) digital delivery of incentives, which can be just as reinforcing as the conventional CM reward system.[47] Typically, individuals receive incentives remotely through text messaging, delivering prompt feedback and rewards, generally through digital financial incentives (prepaid debit cards, gift cards, and vouchers). Getty et al[18] evaluated MPA CM and found superior reductions in alcohol use relative to control conditions.

To date, the only FDA-approved MPAs for SUD treatment are reSET[48] and reSET-O (OUD specific).[27] Both applications use CM to incentivize the completion of addiction-specific modules that consist of CBT and community reinforcement approach (CRA) interventions. Patient data flow to a clinicianfacing dashboard to inform in-person sessions. CBT has well-established data, supporting its efficacy in SUD treatment (see further); however, augmentation with CM appears to add value.[49–52]

**Cognitive Behavioral Therapy.—**Cognitive behavioral therapy addresses cognitive distortions (eg, unhelpful thinking) and problematic behaviors through developing healthy cognitions and adaptive behaviors.[53] Cognitive behavioral therapy has been extensively studied within SUD populations, with solid evidence when delivered through computer-based applications.[53] A review of computer-based asynchronous technology delivering CBT for alcohol use disorder (AUD) showed that CBT compared favorably (small effect) to a "minimal treatment" control group ($g$=0.20; 95% CI, 0.22-0.38) and more favorably as adjunctive to conventional therapy ($g$=0.30; 95% CI, 0.10-0.50); effects sustained over the 12-month follow-up. However, when asynchronous technology-driven CBT was compared with treatment as usual or active in-person CBT, its effects were nonsignificant.[53] The authors highlight a wide variation in the amount of CBT available within these interventions and the variability in participant engagement.[53]

**Digital Recovery Support Services.—**Recovery support services is "an individualized, intentional, dynamic, and relational process involving sustained efforts to improve wellness."[54] This involves practical environmental enhancements through assisting with employment, housing, social networks, coping skills, and activities that promote self-esteem, self-efficacy, and a sense of purpose. These are typically nonclinical services delivered in the community over an extended period.[54] A review of all types of digital RSS efficacy found few experimental studies; those that were experimental showed a positive effect on abstinence corelated with the digital intervention treatment.[54]

Community reinforcement approach is an RSS approach that emphasizes that substance use competes with delayed prosocial reinforcers and promotes skills training to increase access to and satisfaction with drug-free sources of reinforcement.[55] Asynchronous CRA modules teach skills to improve psychosocial functioning (eg, drug refusal skills).[48]

Community reinforcement approach and CBT are major components of 2 FDA-approved MPAs reSET[48] and reSET-O.[27] Contingency management is also a major component of these programs. To differentiate the treatment effect of CRA/CBT from CM, 1 study compared those receiving CM alone with CRA/CBT plus CM. It noted the CRA/CBT plus CM group had an average increase of 9.7 abstinent days (95% CI, 2.3-17.2) with a significant reduction in treatment discontinuation (HR, 0.47; 95% CI, 0.26-0.85) compared with CM alone.[27]

**Approach-Based Modification.—**Approach-based modification repeatedly presents individuals with substance-related pictures to which they must make an avoidance movement (eg, pushing away images of alcohol using a joystick) and conversely perform an approach movement in response to non—substance-related image (eg, pulling on the joystick). Theoretically, through these actions, individuals learn to avoid substance-related cues automatically. This approach has previously been incorporated into an MPA format with mixed results. One ABM application targeting alcohol use failed to demonstrate significant changes in weekly alcohol consumption or AUD identification test scores.[56] However, a similar study identified a significant reduction in alcohol consumption after both 3-week and 3-month follow-ups.[57]

**Motivational Enhancement Therapy.—**Although a mainstay of traditional counseling for SUD, motivational therapeutic interventions often require a dynamic interaction between provider and patient that is difficult to emulate through a computer-based module. Subsequently, studies have focused on telephone or text messaging to apply MET.[58] Application-based MET has resulted in mixed effects for smoking cessation,[59,60] and the included coaching applications in this review were not effective.

**Behavioral Activation.—**Behavioral activation is an approach that attempts to replace the negative behaviors of substance use with positive behaviors, typically involving physical effort.[61] Although targeting activity is usually an RSS intervention,[54] a recent study reported mixed outcomes for using an MPA that focused on increasing physical activity to improve SUD outcomes.[62]

## Engagement

Program attendance and participation are essential aspects of mental health treatment.[63] For MPAs, participant time, effort, and attention can measure user engagement.[64,65] Greater engagement has been correlated with improved abstinence rates among applications incorporating CM to encourage CBT-module utilization.[66] Unfortunately, engagement in health-related applications is low overall. A review of individual user data from over 100,000 participants found that the average health application engagement period was 5.5 days.[67] Similarly, an examination of engagement with popular mental health applications from commercial marketplaces found that only 4% of users who downloaded an application opened it again after 15 days.[68] Total application downloads have not correlated with increased engagement, with some of the most downloaded mental health—related applications being the least used.[69]

In traditional psychotherapeutic interventions, engagement often depends on the therapeutic alliance between patient and provider. For SUD MPAs, building this is important. Mindfulness/meditation and peer support applications have higher retention and daily usage than applications incorporating mental health treatment strategies like mood tracking, breathing exercises, and psychoeducation. CM within applications improves engagement similarly to CM in traditional SUD treatment.[67] Low-intensity support from a clinician or peer via messaging or telephone produces significantly more engagement than fully automated applications.[67] This support typically aims to maintain patient adherence to the application and monitor progress through periodic symptom assessments. However, support may also include assistance with understanding therapeutic concepts and triaging patients who do not respond to the intervention.[70]

The content delivery method also impacts engagement. Providing timely, positive, data-driven feedback to users throughout the day can improve engagement in health applications.[71] As recommended by the National Institute of Health, MPA content is typically targeted to an eighth-grade reading level, which may be a barrier to some user's engagement. The quality of the presentation of the application can also impact participants' engagement with the application. For some patients, MPA functionality and esthetics can be more important than evidence-based psychotherapeutic components for

engagement.[72] Gamification, text-based and phone-based support from a recovery coach, and direct links to a quitline may appeal to MPA users, enhancing engagement. Despite the wide acknowledgment that engagement is essential to application efficacy, there is little information on how much engagement is necessary for SUD treatment.[73]

### Therapeutic Goals

SUD outcome measures typically focus on reduction or cessation of use. However, treatment retention, quality of life, decreased relapse frequency, and craving reduction are also important.[74] Understanding an MPA's content and goals increases consistency between the MPA and treatment provider.[14]

### How to Analyze an SUD Application

The APA framework consisting of clinical foundation, engagement, and therapeutic goals helps to organize the data in a provider-friendly way that can be conveyed to patients requesting information on the most evidence-based MPAs for SUD treatment (Figure 3).[16]

As new applications enter the market daily, physicians must guide their patients to applications that follow an evidence-based approach to SUD intervention. CBT, CM, and RSS appear to have the most independent research associated with positive outcomes. These modalities are often combined with or added to other modalities. MPAs containing clinical and peer support engagement strategies, participation rewards, immediate feedback, and esthetically appealing design will garner the engagement necessary for clinical benefit. Current evidence supports MPAs that encourage reduction and/or discontinuation of use and improvement of recovery-oriented behaviors, such as treatment retention.

## DISCUSSION

The results found in this review emphasize the need for caution when recommending an MPA to a patient with SUD. First, most SUD MPAs on commercial application stores are not researched and have little evidence for their claims. Second, when research is conducted, there is no significant general MPA effect on SUD-related treatment outcomes, highlighting that simply using an MPA to target substance use without an understanding of the content is insufficient. Third, content type changes outcomes. Many of the studies examined MPAs that included a combination of modalities, but those studies that incorporated 1 or more CM, RSS, and CBT content types were most often associated with significant outcomes. This suggests that an evidence-based treatment paradigm must be incorporated for meaningful results. However, a fourth point is that MPA pilot studies can have promising results that dissipate once compared with a control group, introducing potential bias (digital placebo effect).[75] Another critical insight from this review is that MPAs may not be well-suited for every SUD stage. When considering brain disease model of addiction by Koob and Volkow,[76] most MPAs identified were targeting the preoccupation/anticipation stage. The therapeutic content emphasized not only providing skills and strategies to decrease substance use but also impacting incentive salience through motivational changes (ie, rewards) for meeting these goals.[76]

### Limitations

It is important to remember that this is not a complete review of all existing MPA studies for SUD because it simply reflects the outcomes of trials included in published reviews. Another unresolved issue from this review is the exact amount of content exposure required to receive adequate MPA response. The variation in the amount each application was used (ie, receipt of the intervention) was unknown. Study lengths also differed. In addition, the number of participants analyzed versus the number randomized was inconsistent across studies (Table 1).[17–23] For intent-to-treat analyses, not all participants will have received the same amount of treatment owing to dropout. These factors increase uncertainty in reported effect sizes. Finally, it is essential to remember that MPAs, unlike pharmaceuticals, do not remain static throughout testing. MPA content and interface design can be rapidly updated and pushed to the user. Therefore, new iterative approaches that quickly incorporate feedback from patients and providers may improve and accelerate efficacy. Unfortunately, this ongoing iterative development may clash with the FDA's digital therapeutic software as medicine paradigm, which requires FDA approval for every change.

## CONCLUSIONS

SUDs remain a leading cause of death and disability worldwide. Increasing SUD service demand coincides with treatment barriers that include personal (eg, stigma, shame, and guilt) and systemic issues (eg, availability, affordability, and access), which warrant the development of novel strategies for addiction treatment. MPA utilization is a form of treatment augmentation and does not replace gold standard practices; however, they have a high potential to increase reach and overcome social and territorial disparities, resulting in a high population-level impact. MPAs deliver convenient, discrete, self-paced, and affordable treatment. Furthermore, digital platforms and MPA delivery methods may enhance the engagement of specific populations, such as younger cohorts, while functionality and esthetics may improve MPA acceptability. Although evidence to date does not generally support the use of MPAs, MPAs with aspects of CM, CBT, and RSS have the best evidence thus far. Blinded RCTs with intention-to-treat statistical methods are needed for accurate efficacy data, which will help providers navigate the deluge of available MPAs. The APA's framework and the included meta-analysis can effectively equip clinicians and patients with the tools to make evidence-based decisions for their individualized treatment. With increasing options for MPA selection, it is essential to recognize that not all approaches will help all patients.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Grant Support:

The work was supported by the National Institutes of Health (grant U01 AA27487 and R18 HS029774-01); the Terrance and Bette NobleFoundation, Mayo Clinic Kern Centerforthe Science of Health Care delivery; and the Mayo Clinic SC Johnson Genomics of Addiction Program.

## Abbreviations and Acronyms:

| | |
|---|---|
| **ABM** | approach-based modification |
| **APA** | American Psychiatric Association |
| **CBT** | cognitive behavioral therapy |
| **CM** | contingency management |
| **CRA** | community reinforcement approach |
| **MET** | motivational enhancement therapy |
| **MPA** | mobile phone application |
| **OUD** | opioid use disorder |
| **RSS** | recovery support strategy |
| **SUD** | substance use disorder |

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## ARTICLE HIGHLIGHTS

- Approximately 10% of individuals suffering from substance use disorders (SUDs) receive treatment.
- With the proliferation of smartphones, SUD mobile phone applications (MPAs) are downloaded by thousands daily.
- This meta-analytical umbrella review of reviews shows there are insufficient data to assert that MPAs, in total, significantly improve SUD-related outcomes. However, application-based cognitive behavioral therapy, contingency management, and recovery support services show promising results.
- SUD MPAs contain different interventions with varying levels of evidence. Thus, developing a systematic methodology for assessing MPA quality and evidence-based content will better equip clinicians to identify MPAs of clinical utility.

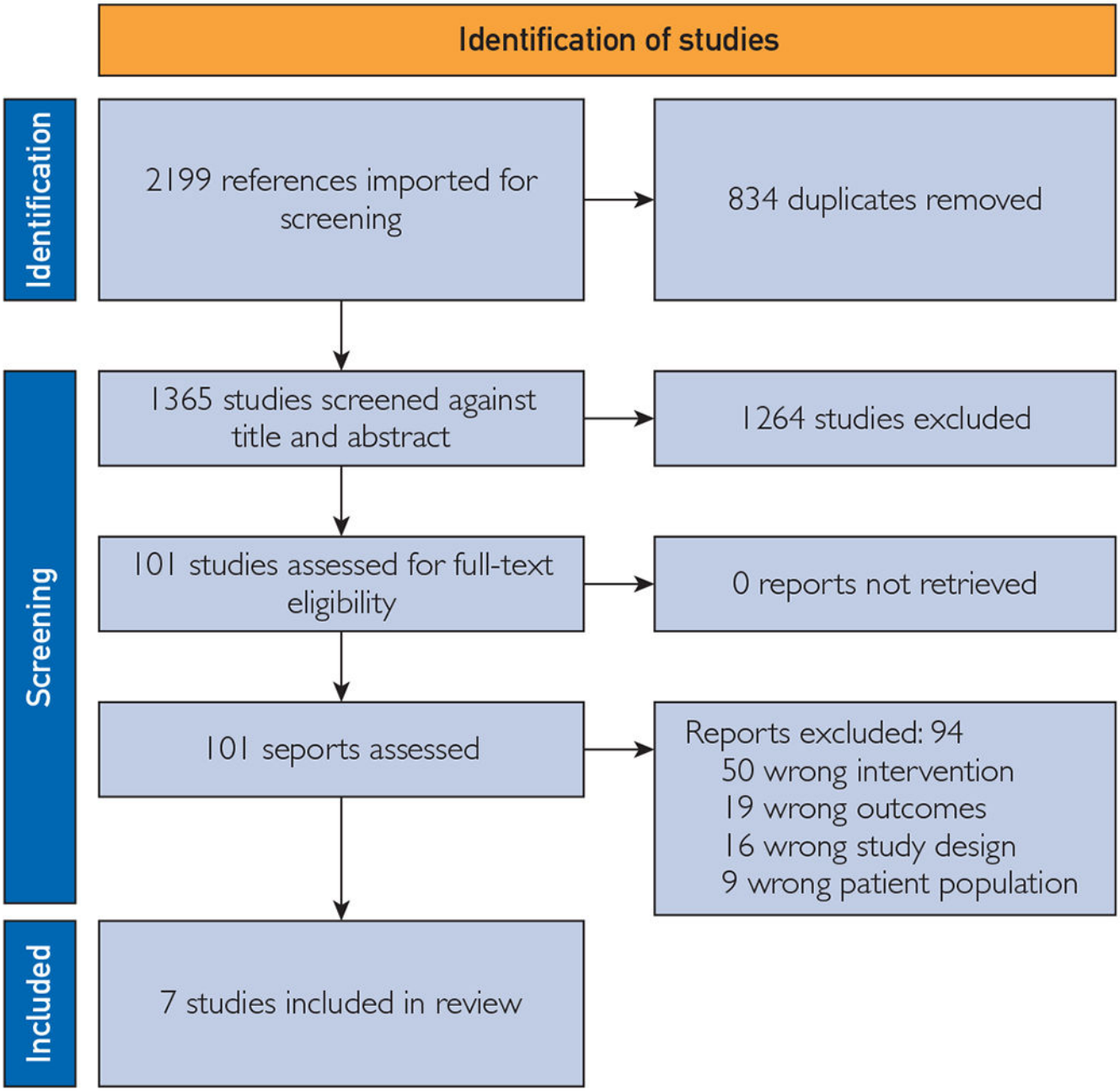


**FIGURE 1.**
PRISMA[24] flow diagram. Seven reviews remained after comprehensive systematic review.

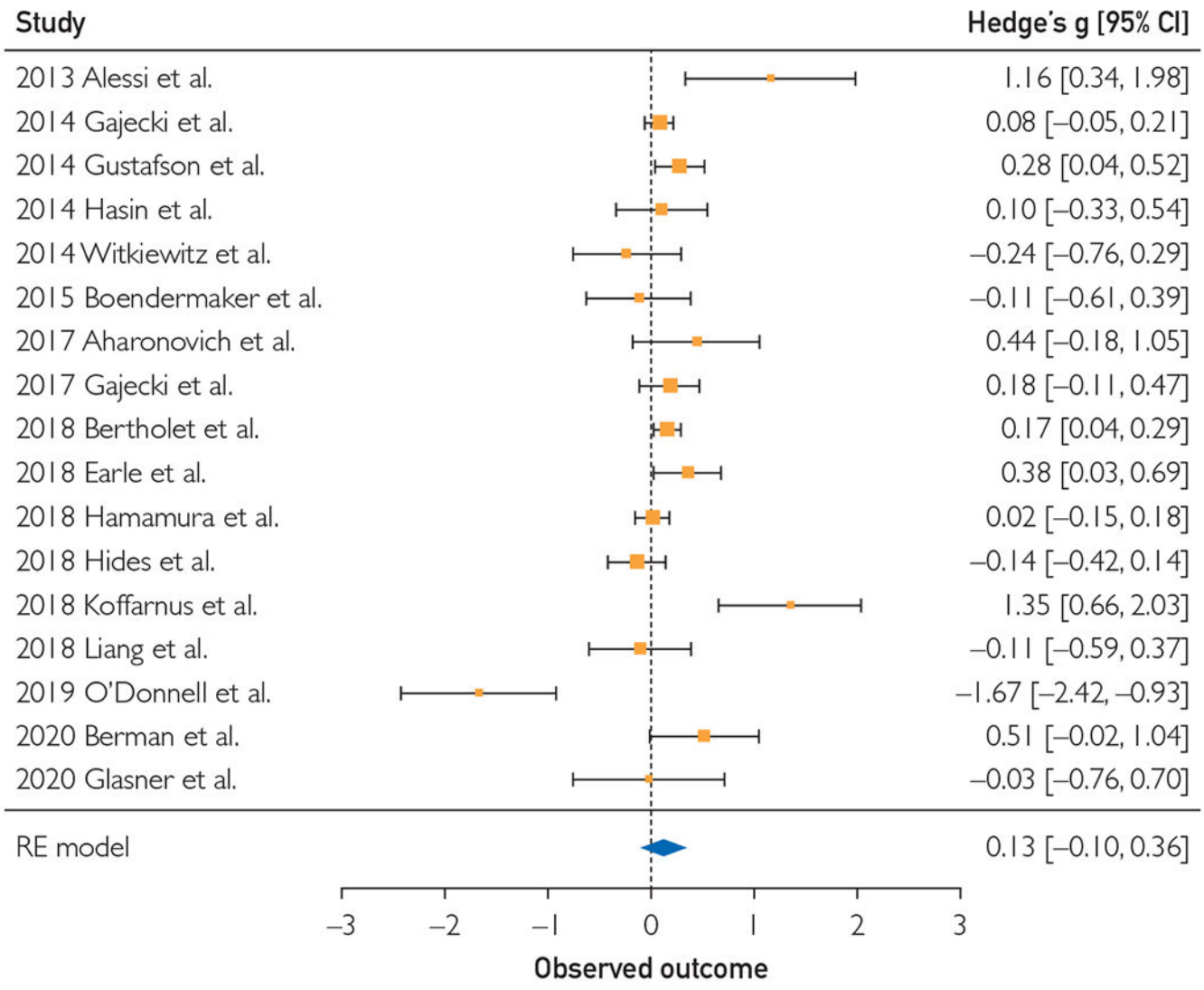


**FIGURE 2.**

Forest plot of applicable studies. Calculations were performed in R v4.3.0 with packages dplyr, meta, and metafor, and figures were created using functions forest. The Hedges *g* effect size for all application content types in decreasing substance use was 0.137 (95% CI, −0.056 to 0.330; $P$=.16) compared with control; $\tau^2$ was 0.164 (SE=0.066), and $I^2$ was 87.81%, indicating high heterogeneity.

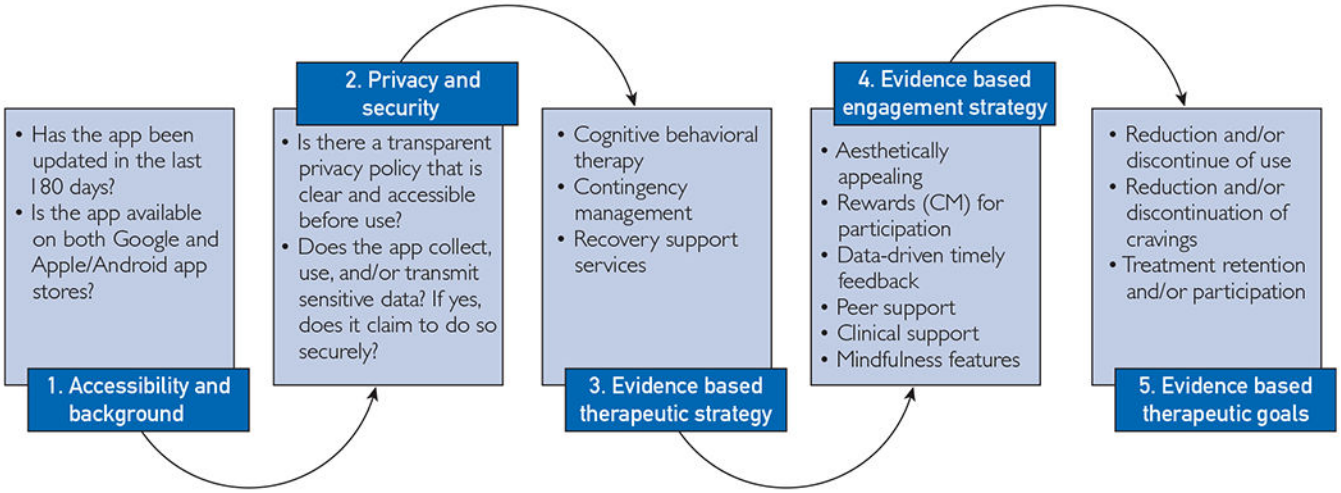


**FIGURE 3.**

Mobile phone application assessment strategy based on the American Psychiatric Association framework.

**Table 1.**

Summary of Included Review Articles

| Study | Therapeutic intervention modality | Study types included | Drug studied | Outcome | Therapeutic modalities associated with positive outcomes |
|---|---|---|---|---|---|
| Inventory and analysis of controlled trials of mobile phone applications targeting substance use disorders: a systematic review[17] | Various application-based therapeutic modalities | RCTs | 22 articles (included tobacco and binge eating) | A total of 4 for alcohol and 1 for other substances use applications reported results supporting effectiveness | RSS and CBT, had the best results; some supported for ABM and meditation |
| Mobile telephone-delivered contingency management interventions promoting behavior change in individuals with substance use disorders: a meta-analysis[18] | CM | RCT | AUD | The random-effects meta-analyses produced pooled effect sizes of; PNS ($d$=0.94; 95% CI, 0.63-1.25), demonstrating better outcomes across the CM conditions | CM alone delivered through applications decreased substance use as measured by remote monitoring strategies |
| Smartphone apps for managing alcohol consumption: a literature review[19] | Various RSS strategies | RCT | AUD | One of the 7 applications found a significant reduction in “risky drinking days” among participants using an application compared with controls given only treatment as usual ($P$=.003) | RSS showed strong results |
| Using technology to assess and intervene with illicit drug-using persons at risk for HIV[20] | RSS and CBT self-management modules | Pilot/incomplete RCTs | Poly drug use | 5 of the 8 intervention studies reviewed in this study are still in progress or only report. Others were pilot studies | CBT modules held promise |
| Systematic review of smartphone apps as a mHealth intervention to address substance abuse in adolescents and adults[21] | Range of approaches: ABM, RSS, CBT, and mindfulness | 5 of the studies implemented an RCT design | Most of these studies (12 of 17) target alcohol addiction; 2 studies target cannabis use | Nonrandomized studies tended to provide positive results. RCTs showed mostly negative results | DBT, CBT, and MET showed promise but RSS approach was the most promising |
| The current evidence for substance use disorder apps[22] | Self-monitoring, normative feedback, goal-setting, craving self-management, and social support cognitive bias modification | Mix of small RCTs and single-arm pilot published between 2020 and 2022 | Alcohol, OUD, and smoking | 2/6 positive findings | RSS and CRA appear helpful |
| Mobile apps to reduce tobacco, alcohol, and illicit drug use: systematic review of the first decade[23] | Applications varied substantially in the underlying theoretical approaches | Mixed | 20 studies met eligibility criteria | Six of the 20 application interventions reported significant reductions in substance use | RSS, CBT, and other approaches appeared helpful |

Abbreviations: AUD, alcohol use disorder; CBT, cognitive behavioral therapy; CM, contingency management; CRA, community reinforcement approach; EMA, ecological momentary assessment; OUD, opioid use disorder; RCT, randomized controlled trial; RSS, recovery support service.

**TABLE 2.**

Summary of Articles Included in the Meta-Analysis[a,b]

| Reference, year (MPA group) | Study type | Study length | Population | Comparison | Outcome | Treatment R/C/A (n) | Treatment MC (SD)[a] | Control R/C/A (n) | Control MC (SD)[a] |
|---|---|---|---|---|---|---|---|---|---|
| Alessi and Petry,[28] 2013 (CM) | RU | 1 mo | Alcohol consumption not meeting diagnostic criteria | CM, messaging, breathalyzer vs messaging, breathalyzer | Drinking days per month | 15/15/14 | −12.6 (5.2) | 15/15/15 | −2.4 (4.4) |
| | | | | | Drinks per drinking day | | −1.3 (1.9) | | −0.7 (2.6) |
| Gajecki et al,[29] 2014 (RSS) | RU | 7 wk | University students, AUDIT >5 (F) and >7 (M) | PartyPlanner application vs assessment only | Total drinks per week | 640/388/388 | −0.98 (75.8) | 649/500/500 | −0.53 (5.6) |
| Gustafson et al,[30] 2014 (RSS) | RU | 12 mo | Alcohol dependence, residential program | A-CHESS application vs TAU | Risky drinking days | 170/132/132 | −0.26 (0.4) | 179/139/139 | −0.15 (0.4) |
| Hasin et al,[31] 2014 (MI) | NRU | 2 mo | HIV+, alcohol dependence | MI, HealthCall-S vs MI, HealthCall-IVR (earlier study) | Drinks per drinking day | 39/37/39 | −5.4 (5.9) | 43/38/43 | −4.5 (3.2) |
| | | | | | Abstinence | | −21.1 (22.7) | | −20.8 (19.6) |
| Witkiewitz et al,[32] 2014 (other) | RU | 1 mo | College students, 1+ episode of heavy drinking in past 2 w | BASICS-Mobile vs assessment only | Drinks per drinking day | 32/30/30 | −0.74 (2.4) | 29/26/26 | −1.41 (2.9) |
| | | | | | Heavy drinking days | | −0.24 (1.5) | | −0.55 (1.2) |
| Boendermaker et al,[33] 2015 (ABM) | NRU | 1 mo | University students | Mobile application vs computer | Total drinks in past 2 wk | 31/30/30 | −5.1 (17.5) | 32/32/32 | −7.0 (15.6) |
| Aharonovich et al,[34] 2017 (MI) | RU | 2 mo | HIV+ adults | MI, HealthCall vs MI | Days of drug use | 23/21/21 | −8.17 (4.3) | 24/21/21 | −5.46 (6.5) |
| | | | | | Days of alcohol use | | −7.48 (6.7) | | −4.98 (6.0) |
| Gajecki et al,[35] 2017. (other) | RU | 3 mo | University students, excessive alcohol consumption | TeleCoach application vs assessment only | Total drinks per week | 93/71/71 | −3.8 (9.3) | 144/124/124 | −2.49 (5.9) |
| Bertholet et al,[36] 2018 (RSS) | RU | 6 mo | AUDIT >7 and drinking 15+ drinks weekly | RSS vs assessment only | Total drinks per week | 461/261/461 | −10.0 (15.2) | 516/441/516 | −7.5 (15.1) |
| Earle et al,[37] 2018 (RSS) | RU | 2 mo | First-year university students | CampusGANDER, alcohol-feedback, reflection vs CampusGANDER only | Peak number of drinks per day | 90/72/72 | −1.26 (3.4) | 93/71/71 | 0.02 (3.7) |

| Reference, year (MPA group) | Study type | Study length | Population | Comparison | Outcome | Treatment R/C/A (n) | Treatment MC (SD)[a] | Control R/C/A (n) | Control MC (SD)[a] |
|---|---|---|---|---|---|---|---|---|---|
| Hamamura et al,[38] 2018 (CBT) | RU | 1 mo | Adults working full-time interested in using a phone application | CBT, self-record application vs TAU | Total drinks per week | 306/248/306 | −0.1 (7.3) | 251/224/251 | −0.48 (6.3) |
| | | | | | Peak number of drinks per day | | −0.77 (9.7) | | −0.02 (7.3) |
| Hides et al,[39] 2018 (MI) | RU | 1 mo | 16-25 y old with past-month alcohol use | MI, Ray application vs delayed application access | Total drinks per month | 96/94/94 | −0.23 (1.2) | 101/100/100 | −0.4 (1.2) |
| Koffarnus et al,[40] 2018 (CM) | RU | 1 mo | Adults with active AUD | CM, breathalyzer vs breathalyzer | Drinks per drinking day | 20/20/20 | −4.55 (2.3) | 20/20/20 | −0.45 (3.6) |
| Liang et al,[41] 2018 (other) | RU | 1 mo | Adults in methadone treatment program | Other, S-Health vs text messaging | Days of drug use | 50/43/49 | −0.62 (2.0) | 25/25/25 | −0.88 (2.9) |
| O'Donnell et al,[42] 2019 (RSS) | RSB | 1 mo | Adults with past week alcohol use motivated to decrease use | Minimize application vs assessment only | Risky drinking days | 25/22/22 | −0.1 (0.15) | 20/16/16 | −0.37 (0.2) |
| Berman et al,[43] 2020 (other) | RU | 6 wk | University students, AUDIT >5 (F) and >7 (M) | TeleCoach application vs Ctrl application | Total drinks per week | 42/26/26 | −20.0 (17.1) | 47/31/31 | −12.52 (11.6) |
| Glasner et al,[44] 2016 (CBT) | RU | 3 mo | HIV+ ART-compliant adults with AUD | CBT, messaging vs pamphlet | Days of alcohol use | 17/13/13 | −10.4 (8.7) | 18/16/16 | −9.55 (9.2) |
| | | | | | Alcohol intoxication days | | −4.23 (5.8) | | −5.32 (8.1) |

[a]Abbreviations: ABM, approach-based modification; ART, antiretroviral therapy; AUD, alcohol use disorder; AUDIT, alcohol use disorder identification test; CBT, cognitive behavioral therapy; CM, contingency management; F, female; MI, motivational interviewing; M, male; MC, mean change; MPA, mobile phone application; NRU, nonrandomized with participants unblended; R/C/A, randomized/completed/analyzed for that study; RSB, randomized single-blind; RSS, recovery support service; RU, randomized with participants unblended.

[b]MPA group refers to grouping used in subgroup meta-analysis; other refers to nonspecific coaching. Alcohol dependence was assessed using Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, and AUD using Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition. Episode of heavy drinking refers to 5/4 drinks per occasion for men/women.