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Review Article

Opioid Use Disorder

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# Digital Therapeutics in the Management of Opioid Use Disorder: A Systematic Review of Emerging Technologies and Clinical Outcomes

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Opioid use disorder (OUD) poses a major global health burden, with limited access to traditional treatment in many regions. Digital therapeutics (DTx) offer, noble tools to support treatment, enhance accessibility, and improve outcomes. The objective of the study is to systematically review the current evidence on the effectiveness, implementation, and outcomes of DTx in the management of OUD. A thorough literature was searched using PubMed, Science direct, Google scholar et cetera, from 2015 to 2024, which included randomize control trials (RCTs), systemic reviews, and real-world studies evaluating digital interventions (apps, telehealth, AI based tools, wearable for OUD. A total of 28 studies met the inclusion criteria. digital interventions demonstrated improved treatment, retention, opioid abstinence, and patient engagement. Tools such as reset-O, telehealth, CBT based mobile apps and AI driven systems showed efficacy in both clinical and real-world settings. Barriers included digital, illiteracy, privacy, concerns, and Limited regulatory frameworks, especially in low- and middle-income countries. Digital therapeutics present a promising adjunct or alternative to conventional OUD treatment. Tailored implementation, Cultural Adaptation, and regulatory support are essential for maximizing their impact.

**Keywords:** Digital health, Opioid Addiction, Telepsychiatry, CBT Apps, reSET-O, AI in addiction, mHealth, Digital Interventions

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## Introduction

OUD continues to escalate as global health issue, with over 60 million people estimated to have used opioids in 2022, & millions other suffering from opioid dependence & its complications.**[1]** Traditional treatment modalities such as methadone, & psychosocial interventions like Cognitive Behavioral therapy (CBT), are well established but face challenges in accessibility, stigma & patient retention.**[2]** Digital therapeutics (DTx) have developed as innovative, scalable, & evidence-based healthcare delivery options, including treatment for OUD. These include smartphone applications, prescription digital treatments (e.g., reSET-O), AI-powered behavioral tracking tools, wearable biosensors, & telehealth systems. These tools are designed to promote abstinence, increase treatment adherence, & provide real-time behavioral interventions.**[3],[4]** Promise of DTx resides in its ability to fill treatment gaps, particularly in rural & underprivileged populations. For example, reSET-O, first FDA-approved digital therapy for OUD, demonstrated enhanced abstinence & retention rates in both randomized controlled trials & real-world appl. (Maricich et al., 2021).**[5]** Similarly, telemedicine & mHealth initiatives increased access to MOUD during COVID-19 epidemic, With results equivalent to in-person therapy.**[6]** Despite the good results, challenges to widespread adoption persist. These include worries regarding digital literacy, data privacy, governmental backing, and a lack of culturally appropriate solutions in low- and middle-income nations like India.**[7]**

The objective of this systematic review is to consolidate and evaluate the current data on digital therapy tools in OUD treatment, focusing on their clinical efficacy, real-world applicability, and the problems associated with implementation across various settings.

## Materials and Methods

### Search strategy

This systematic review was carried out in accordance with the PRISMA guidelines. [Figure 1]. A comprehensive literature search was conducted using the PubMed, ScienceDirect, and Google Scholar databases for publications published between January 2015 and March 2024. The following search terms and Boolean operators were used: ("Opioid Use Disorder" OR "OUD") AND ("digital therapeutics" OR "mobile health" OR "telemedicine" OR "CBT apps" OR "reSET-O" OR "AI in addiction" OR "wearables" OR "digital health").

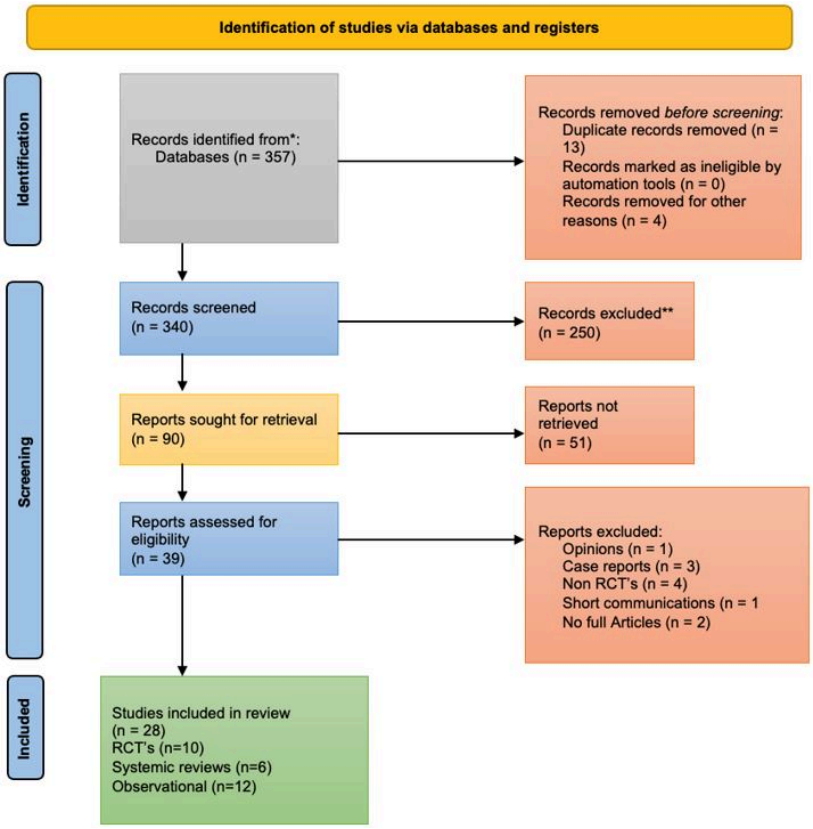


**Figure 1: PRISMA 2020 flowchart.**

### Inclusion and Exclusion Criteria

**Inclusion criteria:** Research published in peer-reviewed journals between 2015 and 2024. Randomized controlled trials (RCTs), systematic reviews, meta-analyses, and real-world implementation research. Digital treatments for managing OUD and human participants.

**Exclusion criteria** for non-English language publications. Case studies, editorials, and conference abstracts without complete text. Studies that are not focused on OUD or do not include digital therapy approaches.

### Data Extraction and synthesis

To identify appropriate studies, two independent authors examined the titles and abstracts. Full texts were retrieved for potentially relevant articles. Disagreements were resolved by discussion and consensus. The following key data were extracted: study design and location, sample size and demographic characteristics, kind of digital intervention, Outcome measures (e.g., abstinence rates, treatment retention, engagement, satisfaction), key findings, and conclusions.

### Quality Assessment

The Cochrane Risk of Bias Tool was used to assess the quality and risk of bias for all included RCTs. Systematic reviews and observational studies were assessed using the AMSTAR 2 checklist and the Newcastle-Ottawa Scale, respectively.

## Results

### Overview of Included Studies

After screening and full-text evaluation, 28 of the 357 records found during the database search met the criteria for eligibility requirements. They included: Ten randomized controlled trials (RCTs), six systematic reviews or meta-analyses, and 12 real-world implementation or observational studies. These studies included both high-income countries like the United States and Canada, as well as middle-income situations like India.

**Table 1: Comparative Summary of RCTs Evaluating Digital Interventions for OUD. (n=10)**

| Study (Year) | Sample & Population | Digital Intervention | Comparator | Primary/Secondary Outcomes | Key Findings (Effect Size) |
|---|---|---|---|---|---|
| **Maricich et al., 2021** (reSET-O trial-USA) | N=170 adults with DSM-IV OUD on buprenorphine in outpatient treatment. | reSET-O (12-week prescription digital therapeutic; 67 interactive CRA modules + contingency management via mobile app) | Treatment-as-usual (TAU): buprenorphine + biweekly clinician visits + urine monitoring + CM vouchers. | Primary: Opioid abstinence (urine-negative) during weeks 9–12; Treatment retention. Secondary: Adverse events. | Significantly higher opioid abstinence in digital group (77.3% vs 62.1% abstinent in weeks 9–12, p = 0.02; OR ~2.08). Retention improved (hazard of dropout 0.49 vs TAU). No difference in adverse events. |
| **Shi et al., 2019** (CBT4CBT-Bup- USA) [8] | N=20 adults with OUD (DSM-5) on office-based buprenorphine maintenance. | **CBT4CBT-Buprenorphine** (web-based CBT program tailored for OUD, self-guided modules) plus standard buprenorphine care. | Standard buprenorphine treatment alone (office-based, physician visits). | Primary: Treatment retention; Opioid/cocaine abstinence (urine toxicology). Secondary: Abstinence from all drugs. | Digital CBT group had higher opioid-negative urine rates (91% vs 64% at end of 12 weeks, p ≈ 0.05) and higher overall drug abstinence (82% vs 30%, p = 0.004). Greater treatment duration (82.6 vs 68.6 days) in CBT4CBT group. |
| **Sigmon et al., 2023** ("TAB" trials-USA) [9] | Two RCTs, each N=50 adults with untreated OUD in nonrural vs rural settings. | **Technology-Assisted Buprenorphine (TAB) –** 24-week program with remote buprenorphine initiation, telehealth counselling, digital adherence monitoring, plus overdose education (in one trial) | Standard buprenorphine treatment (standard duration or without tech-assisted features, depending on trial arm). | Primary: Illicit opioid abstinence (urine-confirmed). Secondary: Treatment retention. | TAB yielded much higher abstinence: ~85% (nonrural) and 88% (rural) opioid-negative rates vs 21–24% in respective control groups (p<0.001) Treatment retention also improved with TAB (longer duration on buprenorphine) – demonstrating efficacy in both rural and nonrural patients. |
| **Tofighi et al., 2023** [10] (USA) | N=128 adults with OUD inducted on buprenorphine via telemedicine (COVID-era virtual clinic). | **"TeMeS" Text-Messaging Intervention –** Automated daily texts based on medical management model (appointment reminders, adherence prompts, support messages) delivered for 8 weeks. | Treatment-as-usual tele-buprenorphine care (virtual clinic visits, no texting support). | Primary: Feasibility (enrolment, engagement) and Acceptability. Secondary: Treatment retention at 8 weeks (active Rx in week 8) | High enrolment (91% of eligible) and acceptability; no significant difference in 8-week retention (mean ~5.2 vs 5.0 weeks retained, p = 0.68). Participants were generally satisfied with text frequency, though 9% opted out due to message fatigue. |

| | | | | | |
|---|---|---|---|---|---|
| **Kiburi et al., 2023** (Kenya SMS)[11] | N=46 adults with OUD on methadone maintenance (Nairobi clinic). | **CBT-Based SMS Support –** 6-week text messaging program (daily cognitive-behavioural therapy tips, skill reminders, and support texts). | Standard methadone treatment (daily dosing + counselling as usual) with no messaging. | Primary: Reduction in opioid use (self-report and urine tests). Secondary: Treatment retention at 6 and 12 weeks; Acceptability of intervention. | Opioid use decreased in both groups; intervention arm had lower opioid use prevalence (35.7% vs 56.3% at 3 months), but difference was not statistically significant. High retention in SMS group (93% at 6 weeks, 83% at 3 months) and high satisfaction with the texts. |
| **Liang et al., 2018** (S-Health trial- China) [12] | N=75 adults in community methadone programs (Shanghai) with heroin or polysubstance use disorder | **"S-Health" Smartphone App –** Bilingual app for CRA-based self-management:daily ecological momentary assessments (craving, triggers) + educational messages; supervised by social workers | Control group received only weekly health education text messages (no interactive self-monitoring) | Primary: Opioid/drug abstinence (weekly urine tests). Secondary: Self-reported drug use days; user engagement. | After 1 month, urine-verified abstinence improved with the app: 73.8% opioid-negative rate vs 50% in control (26.2% positive vs 50% positive; p = 0.06)<br>Mean days of drug use in past week were significantly lower in the intervention (0.71 vs 2.20, p < 0.05)<br>Users preferred app-based reporting over in-person interviews. |
| **King et al., 2014** (Web-Counselling-USA)[13] | N=67 opioid-dependent outpatients in methadone maintenance program (urban clinic) | **Web-based Videoconferencing Counselling –** Patients received one-on-one counseling sessions via live video ("eGetgoing" platform) instead of in-person. | Standard in-person individual counselling at the clinic (same frequency and content of sessions). | Primary: Counselling attendance; Opioid use (urine tests). Secondary: Therapeutic alliance; Patient satisfaction. | Non-inferior outcomes: Videoconference group attended a slightly higher % of sessions and had comparable weekly opioid-negative urine rates to in-person counseling (approx. 89–91% negative weeks in both; no significant difference).<br>Treatment satisfaction and therapeutic alliance were similarly high in both groups. Patients valued the convenience of remote counselling. |
| **Marsch et al., 2014** (Campbell et al. 2014-USA)[14] | N=160 opioid-dependent adults in methadone maintenance (multi-site clinics) | **Therapeutic Education System (TES) –** Web-based CRA + voucher incentives program used as a partial replacement for standard counseling (patients completed interactive CBT modules in lieu of some clinic sessions). | Standard methadone program with full schedule of clinician-delivered counseling + urine monitoring + vouchers (per clinic protocol). | Primary: Opioid abstinence (urine-confirmed) during treatment; Treatment retention. Secondary: Abstinence at follow-ups (3 and 6 months). | During the 12-week intervention, the TES group achieved higher abstinence rates than standard care (greater proportion of opioid/cocaine-negative weeks) and similar or slightly better retention.<br>However, by 3- and 6-month post-treatment follow-ups, abstinence outcomes between groups were not significantly different (no sustained benefit).<br>Both interventions produced substantial abstinence during treatment. |

*CRA – Community Reinforcement Approach, †CM – Contingency Management, ‡TAU – Treatment as Usual, §OUD – Opioid Use Disorder, ||CBT – Cognitive Behavioural Therapy, ¶MOUD – Medication for OUD, **B/N – Buprenorphine/Naloxone.

Risk of bias (RoB) for included RCTs were assessed using the Cochrane Risk of Bias Tool [Figure 2]

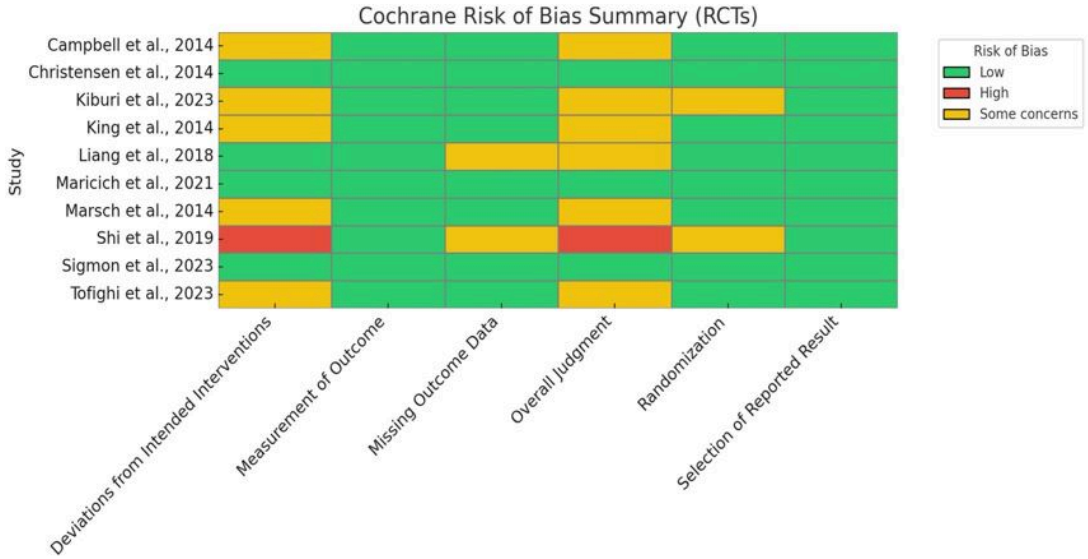


**Figure 2: Risk of bias (RoB) for included RCTs assessed using the Cochrane Risk of Bias Tool**.

**Table 2: Comparative Summary of Systematic Reviews / Meta-Analyses. (n = 6)**

| Author(s) & Year | # of Included Studies and Region | Types of Digital Interventions | Key Findings / Conclusions |
|---|---|---|---|
| **Kiburi et al., 2023 [15]** | 20 RCTs [Global (mostly USA studies)] | Web-based programs, computer-based modules, telephone calls, video conferencing, automated self-management, mobile apps, text messaging (often based on CBT, CRA, MI, etc.) | Mixed effectiveness: about half of trials showed significant improvement in opioid abstinence and a few in treatment retention. Digital interventions were generally acceptable with high patient satisfaction.<br>Effectiveness varied by intervention and patient factors; overall, digital tools can complement OUD treatment but more research is needed, especially in LMIC settings. |
| **Aronowitz et al., 2024 [16]** | 40 (mixed-methods studies) [USA & Canada (COVID-era telehealth)] | Telehealth for buprenorphine ("tele-bupe"), including video/phone inductions and counselling | Patients and providers viewed tele-buprenorphine favourably, citing improved access and convenience. Most supported continued telehealth use post-pandemic.<br>Some challenges were noted (tech issues; providers worried about rapport, while patients felt more comfortable at home). Overall, experiences suggest tele-bupe is acceptable and can improve retention, though providers are divided on when it's most appropriate. |
| **Ward et al., 2024 [17]** | 31 (scoping review) [Global (focus on women with OUD)] | Various digital health interventions for women (mobile apps, tele-counselling, text messaging, web-based support) | Digital tools are being used to support women with OUD in areas like enhancing access to care and recovery support. Interventions addressed unique needs (e.g. pregnancy, childcare) but research is limited. The scoping review found a need for more gender-tailored digital treatments and better evaluation of outcomes in women.<br>Overall, digital health shows promise for engaging women with OUD, but evidence is still emerging. |
| **Lyzwinski et al., 2024 [18]** | 20 (scoping review of qualitative studies) [Global (user perspective focus)] | mHealth and wearables (SMS text messaging, smartphone apps, wearable overdose sensors) | OUD patients have high willingness to engage with mHealth tools to manage their opioid use. Users see mobile apps, text support, and wearables as opportunities to access care and prevent overdoses. They prefer personalized content, encouragement, and involvement of trusted professionals. Key barriers include privacy concerns and limited technology access. Authors emphasize incorporating user feedback (privacy safeguards, training, tailored messaging) to maximize benefits. |
| **Lin et al., 2019 [19]** | 25 (systematic review) [USA (Veterans and general SUD)] | Telemedicine-delivered SUD treatment (videoconferencing or phone-based counseling and MAT for OUD and other SUD) | Telemedicine interventions for SUD (including OUD) showed comparable outcomes to in-person treatment in retention and substance use, with high patient satisfaction.<br>Review noted that tele-SUD treatments often achieved similar abstinence rates and no increase in adverse events. Authors conclude that telemedicine is a feasible, effective alternative for delivering OUD therapy, though more studies were encouraged to confirm long-term outcomes. |
| **Tice et al., 2021 [20]** | 3 digital therapeutics (evaluated via prior studies) [USA (ICER report, various regions of included studies)] | Prescription digital therapeutics as adjuncts to MAT (reSET-O app), recovery support apps ("Connections"), and reward-based apps (DynamiCare) | Evidence was still limited for FDA-authorized digital therapeutics in OUD. For the reSET-O CBT+CM app, an RCT showed improved 12-week abstinence and retention vs TAU, but long-term benefits remain uncertain.<br>Two small uncontrolled studies suggested potential positive outcomes, but due to bias/no control, confidence in effectiveness is low.<br>The ICER panel found no clear net health benefit yet for reSET-O or similar apps compared to standard care.<br>Cost-effectiveness modeling for reSET-O was favorable (within US willingness-to-pay thresholds) if short-term gains are maintained.<br>Overall, digital therapeutics are promising but require more robust evidence. |

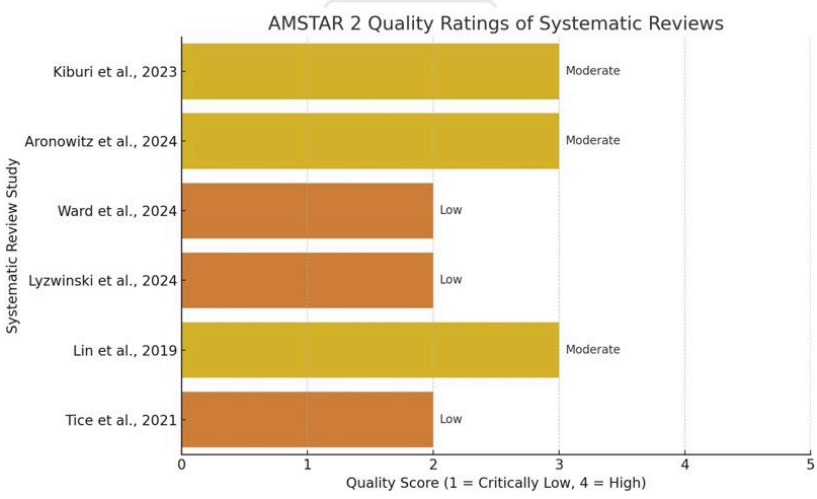


**Figure 3: AMSTAR 2 checklist**

*CBT- Cognitive Behavioural Therapy, † CRA- Community reinforcement approach, ‡ MI-Motivational Interviewing, §RCT- Randomised control trial, ||OUD- Opioid Use disorder, ¶LMIC- Low and middle income countries, **mHealth- Mobile Health, ††SMS- Short message service, ‡‡SUD- Substance use disorder, §§MAT- Medication-Assisted Treatment, ||||FDA- Food and drug Administration, ¶¶TAU- Treatment as usual, ***ICER- Institute for Clinical and Economic Review, †††CM – Contingency Management.

Systematic reviews were evaluated using the AMSTAR 2 checklist [Figure 3].

**Table 3: Comparative Summary of Observational / Real-World Studies (n = 12)**

| Author(s) & Year | Sample, Population and region | Digital Intervention | Main Outcomes | Key Findings / Effect Size |
|---|---|---|---|---|
| **Miller-Rosales et al., 2023 [21]** | 276 health organizations (ACOs) – respondents from hospitals, clinics, and group practices. [USA (national survey of health orgs)] | Various patient-facing digital tools for OUD care (categories: remote therapy/tracking, virtual peer support, digital CBT adjuncts) | Adoption of digital tech for OUD in organizations; usage rate of at least one digital intervention | 33.5% of organizations used ≥1 digital OUD technology (most commonly remote therapy/tracking at 26.5%).<br>Use of digital tools was seen as a complement to existing treatment capacity, not a replacement.<br>Organizations with addiction specialists or mental health registries were significantly more likely to adopt digital tools (e.g. +32% adoption with specialist) |
| **Eibl et al., 2017 [22]** | 3,733 OAT patients across 58 clinics in Ontario (2011–2012) [Canada] | Telemedicine-delivered OAT (methadone or buprenorphine) vs in-person OAT (and mixed modality) | 1-year treatment retention on OAT | Higher retention with telemedicine: 50% 1-year retention via telemedicine vs 39% in-person (mixed tele/in-person: 47%).<br>Tele-OAT patients had 27% higher odds of continuous 1-year retention than in-person (aOR ≈1.27, 95% CI 1.14–1.41).<br>Telemedicine proved an effective alternative for OAT without compromising outcomes. |
| **Hammerslag et al., 2023 [23]** | ~91,000 adults receiving buprenorphine in 2020; ~43,000 were new OUD treatment initiations. [USA (Kentucky & Ohio Medicaid)] | Telemedicine initiation of buprenorphine treatment (during COVID-19 emergency) vs traditional in-person initiation | 90-day retention in buprenorphine treatment; opioid-related overdose within 90 days | Initiating OUD care via telemedicine was associated with better 90-day retention. In Kentucky, 90-day retention was higher with tele-initiation (aOR 1.13, 95% CI 1.01–1.27); in Ohio, aOR 1.19 (95% CI 1.06–1.32).<br>No significant difference in 90-day nonfatal overdose rates between telemedicine and in-person initiation (aOR ~1.0, n.s.).<br>Telehealth start did not increase overdose risk and modestly improved early retention in MOUD. |
| **Lira et al., 2023 [24]** | 1,816 rural OUD patients inducted via a telemedicine buprenorphine program (2020–2022) [USA (14 states, rural areas)] | Telehealth-only MOUD program (remote buprenorphine induction and follow-up) | Treatment retention at 1, 3, 6 months; Medication adherence (urine-verified) at those intervals | Tele-OUD treatment in rural populations achieved encouraging outcomes.<br>Retention: 74.8% at 1month, 61.5% at 3months, 52.3% at 6months. – comparable to outcomes in traditional clinics.<br>Adherence: 69.0% (1mo), 56.0% (3mo), 49.2% (6mo) tested negative for illicit opioids (on buprenorphine).<br>Authors conclude telemedicine is an effective approach for rural OUD care, with retention rates on par with in-person treatment. |
| **Marino et al., 2024 [25]** | 600 adults with OUD on MOUD; 300 self-selected to add an app-based CM, 300 on MOUD alone. [USA (Texas clinical network)] | Smartphone app–based Contingency Management (CM) added to standard MOUD vs MOUD alone (observational cohort) | Days of opioid use at end of treatment; treatment retention (program duration) | Augmenting buprenorphine treatment with a recovery app (CM rewards for abstinence) was associated with improved outcomes. The app-users reported fewer days of opioid use at treatment end and longer treatment retention than those on MOUD alone.<br>In this real-world cohort, patients who opted into the app stayed in treatment significantly longer (on average) and were more likely to complete the program. (Effect sizes: app group had higher abstinence and retention. |
| **Velez et al., 2022 [26]** | 901 OUD patients who initiated the reSET-O therapeutic app (adjunct to buprenorphine); matched with 978 controls (buprenorphine MAT only) [USA (claims data across states)] | reSET-O prescription digital therapeutic (12-week CBT + Contingency Management app) as adjunct to MOUD, compared to MOUD alone (no-app) | Healthcare utilization over 12months post-initiation (inpatient stays, ED visits, readmissions); Buprenorphine adherence (medication possession ratio) | Adding the reSET-O digital therapeutic was linked to significant reductions in healthcare utilization. Over 1year, the reSET-O group had 28% fewer inpatient stays (IRR 0.72, p=0.02) and 56% fewer 30-day readmissions than controls.<br>Total ED visit rates trended 7% lower (n.s.).<br>Net annual healthcare costs were ~$2,800 lower per patient in the reSET-O group. Buprenorphine adherence was higher with the app (MPR 0.85 vs 0.76, p<0.001)<br>Conclusion: reSET-O use is associated with durable real-world benefits – fewer hospitalizations and better medication adherence. |

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|---|---|---|---|---|
| **Ganesh et al., 2022 [27]** | 150 patients with OUD on opioid agonist therapy (methadone/buprenorphine) at a community clinic (New Delhi) [India] | Mobile health (mHealth) readiness and interest – survey of phone ownership, internet use, and willingness to use digital tools for OUD | Access to mobile/internet; willingness to use SMS or apps for OUD care | High digital access and enthusiasm were observed among patients. 88% owned a mobile phone; 70% had internet access. 80% expressed interest in receiving OUD-related text message support, and 60% were willing to use a smartphone app for monitoring substance use. This indicates strong patient readiness for mHealth interventions in an Indian OUD treatment setting. |
| **Kiburi et al., 2023 [28]** | 46 patients on methadone for OUD (Nairobi clinic) – feasibility RCT: 30 received SMS-based CBT messages, 16 control. [Kenya] | SMS text-message intervention (6 weeks of CBT-based daily texts) added to standard methadone treatment (vs standard care only) | Opioid use prevalence (urine test) at 6 weeks; Methadone treatment retention at 6 weeks and 3 months; acceptability ratings | Reduced opioid use with texting (not statistically significant due to small N): at 6 weeks, opioid-positive urine prevalence was 35.7% in the SMS group vs 56.3% in control. Retention on methadone in the SMS group was high (93% at 6 weeks; 83% at 3 months). Participants reported the text-CBT program was highly acceptable and useful (with improved coping skills). This pilot suggests texting CBT is feasible and promising for improving OUD outcomes in Kenya, warranting a larger trial. |
| **Xu et al., 2021[29]** | 40 individuals with opioid use disorder in community compulsory treatment (pilot RCT: 20 with app + standard rehab, 20 standard rehab only). [China (Shanghai)] | CARE app* – Community-based Addiction Rehabilitation E-system (mobile app for self-monitoring, e-learning, mood tracking) plus routine community rehab supervision | Urine-test confirmed abstinence over 6 months (proportion of opioid-negative tests); other measures (longest abstinence, psych assessments) | The digital intervention group achieved better abstinence outcomes. Over 6 months, only 3.3% of urine samples in the CARE app group were opioid-positive, vs 7.5% in the control group – a significant difference in favour of the app (p=0.04). Longest continuous abstinence did not differ significantly between groups. Participants and supervising social workers engaged well with the app's features (education, assessments, GPS tracking). The study demonstrates improved relapse rates with the smartphone-based support in a real-world Chinese setting. |
| **Le et al., 2025 [30]** | 450 patients on methadone maintenance (3 urban clinics) – randomized to: Control (methadone only), Text Message Reminders (TMR), or Motivational Interviewing (MI) sessions. [Vietnam] | SMS reminders for methadone doses (TMR) and/or Motivational Interviewing counseling (MI) to improve adherence, compared to standard MMT alone | Methadone dose adherence, measured at 3 and 6 months (complete adherence = no missed doses; weekend adherence) | Both interventions significantly improved adherence. At 6 months, the MI group's rate of complete adherence was 36% higher than control (RR 1.36). The Text Reminder group also had higher complete adherence than control at 3 months (RR 1.27) and 6 months (RR 1.28). Notably, weekend dose adherence (historically low) improved in the SMS group (RR 1.19 vs control at 6 mo). Conclusion: Weekly counseling and automated daily text reminders each led to significantly better methadone treatment retention/adherence in this real-world setting. |
| **Thomas (Tofighi) et al., 2023** | 128 adults initiating buprenorphine via a low-threshold tele-buprenorphine program (2020) – randomized to automated texting support (TeMeS) vs treatment-as-usual. [USA (New York City)] | "TeMeS" text-message support – daily automated med-management texts (appointment reminders, motivational messages, symptom check-ins) for 8 weeks, added to tele-BUP care vs tele-BUP care alone | 8-week retention in buprenorphine treatment (measured by having an active Rx at week 8); patient engagement & satisfaction | High feasibility but no short-term retention gain in this pilot. Almost all eligible patients agreed to receive texts (91% enrolment), and 88% engaged with the messaging. Retention at 8 weeks was similar between groups (~5.2 weeks on treatment with texting vs 5.0 weeks control; p=0.676). No safety issues were noted. Participants were generally satisfied with the frequency and content. This suggests that while automated texts are acceptable, a more intensive or tailored approach may be needed to measurably boost retention in tele-OUD programs. |

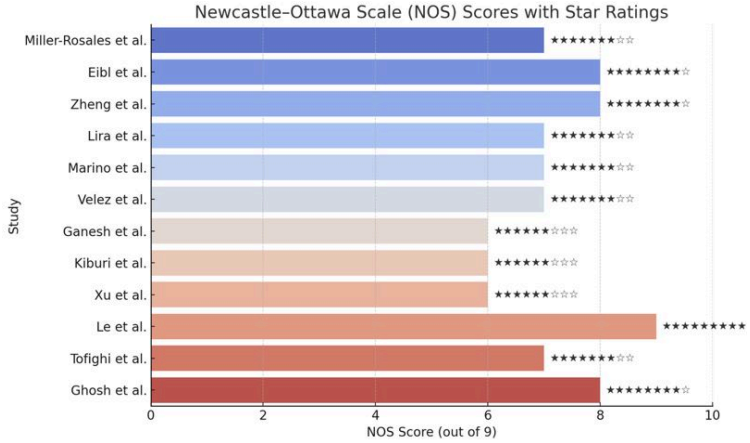


**Figure 4: Observational studies evaluated using the Newcastle-Ottawa Scale (NOS).**

*CRA – Community Reinforcement Approach, †MI – Motivational Interviewing, ‡CBT – Cognitive Behavioural Therapy, §CM – Contingency Management, ||MOUD – Medications for OUD, ¶ACO – Accountable Care Organization , **MAT – Medication-Assisted Treatment (here, MOUD), ††MPR- Medication Possession Ratio, ‡‡IRR- Incidence Rate Ratio, §§ED- Emergency department, ||||TMR-Text message reminder, ,¶¶MMT-Methadone Maintenance Therapy, ***LMIC- Low and middle income country, †††OAT-Opioid antagonist therapy, ‡‡‡aOR- Adjusted Odds Ratio, §§§GPS- Global positioning system, ||||||RR-Relative risk.

Observational studies were evaluated using the Newcastle-Ottawa Scale (NOS) [Figure 4].

**Table 4: Summary of key outcomes across study types in the systematic review**

| Outcome | RCTs (n=10) – Key Findings | Systematic Reviews/Meta-analyses (n=6) | Observational Studies (n=12) – Key Findings |
|---|---|---|---|
| **Abstinence (opioid use)** | ~80% of RCTs showed increased abstinence with a digital intervention vs control. E.g., one trial reported 77% vs 62% abstinent at 12 weeks (digital vs TAU). [31] Another found digital CBT users had 9.7 more abstinent days (Christensen et al., 2014). Some RCTs (20%) found no difference. | Convergent evidence of modest improvements in abstinence. One review found 50% of trials had significant benefit (Kiburi et al., 2023). Others report small-to-moderate effect sizes favouring digital. No review found worse outcomes with digital. | Consistently high abstinence rates reported with digital use. In a 3,144-patient dataset, 66% were abstinent at end of 12 weeks (missing=use), and 91% abstinent when counting only those providing data. Extended 24-week digital treatment yielded 86% abstinence (missing=use) (Maricich et al., 2021). All observational studies noted reductions in self-reported opioid use. |
| **Relapse/Continuous Abstinence** | Digital arms often delayed relapse. E.g., longest abstinence streaks were longer in digital groups (by ~2–3 weeks in some trials). Time to first opioid use was prolonged in several studies. | Not a focus of quantitative meta-analysis, but narrative syntheses note fewer relapse events when digital tools are effective. | Real-world data show sustained engagement can keep patients opioid-free longer. No overdose events were reported during digital treatment in case series. |
| **Retention in Treatment** | 4 of 10 RCTs showed significantly improved end-of-treatment retention with digital adjuncts (Kiburi et al., 2023). Example: 80% retained with digital vs 64% with standard care (HR ~0.5 for dropout). [32] Other trials saw no drop-off attributable to digital use. | Reviews note mixed retention outcomes (only ~20% of trials positive (Kiburi et al., 2023). Overall, digital interventions appear retention-neutral to mildly beneficial. Long-term retention effect unclear due to short follow-ups. | High retention observed in practice: ~74% of patients completed 12-week digital treatment (Maricich et al., 2021). Among those who continued to a second 12-week course, >91% were still in treatment at 24 weeks (Maricich et al., 2021). An app-based contingency management cohort had longer treatment duration vs non-app users (Marino et al., 2024). |
| **Acceptability & Satisfaction** | Generally high – most RCTs reported favourable patient feedback (e.g., high usability scores, few complaints). Engagement levels in trials (sessions completed) indicate good acceptance. | Universally reported as high. Patients find digital modalities acceptable and would recommend them (Kiburi et al., 2023). No major concerns in reviews aside from need for tailoring. | Very high – surveys show 85–100% of users satisfied. In one pilot, >90% rated the digital program "good/excellent" and would reuse/recommend (Monico, et al., 2024). High uptake in real-world programs also reflects acceptability. |
| **Feasibility & Scalability** | Proven feasible in controlled settings – high completion of digital sessions in most trials. Some RCTs delivered interventions fully online with success. | Highlight broad applicability: interventions via web, phone, text, apps all feasible. Emphasize need to expand to new settings (e.g., LMICs) for scalability. | Demonstrated at scale: thousands treated with digital tools in routine care (Maricich et al., 2021). Programs rolled out state wide show scalability. Technology infrastructure and training are required but manageable as shown in pilot implementations. |
| **Barriers/Limitations** | Some patients disengage early (tech not a fit for all). Short trial durations limit insight on long-term effects. Some RCTs had small N. Selection bias: participants often motivated treatment-seekers. | Heterogeneity of interventions complicates pooling data. Mostly US-based studies – results may not generalize globally (Kiburi et al., 2023). Lack of data on certain groups (older adults, low-resource settings). | Digital divide concerns (access to devices/internet) in broader population. In studies, support was provided – real-world users without support may face access issues. Sustainability and payer coverage remain challenges; current real-world studies rely on grant or pilot funding. |

*TAU = treatment-as-usual, †HR = Hazard ratio

# Discussion

**Interpretation of Main Findings:**

In this systematic review, investigators discovered that digital treatments for OUD show potential in improving clinical outcomes, however the results varied between research. Approximately half of the randomised trials analysed indicated significantly higher opioid abstinence rates in individuals receiving a digital intervention compared to control groups (Kiburi et al., 2023). However, increases in treatment retention were less common; only a small number of studies found significantly improved retention with digital therapies. This implies that, while technology-enhanced therapies can help many patients achieve short-term abstinence, sustaining long-term commitment in care remains difficult. Importantly, participants in these research consistently rated digital interventions as acceptable, with high satisfaction rates (Kiburi et al., 2023). High user acceptance demonstrates that individuals with OUD are willing to interact with digital modalities of care, which is a necessary condition for any intervention to have a real-world impact. The digital tools studied ranged from web-based therapy programs to computer or smartphone applications, SMS text message support, phone/video tele-counselling, and automated self-management systems (Kiburi et al., 2023). These platforms provided evidence-based therapeutic content (e.g., cognitive-behavioural therapy, contingency management, community-reinforcement techniques, motivational interviewing) via digital means (Kiburi et al., 2023). Given this variability, it is not surprising that outcomes differed from study to study; factors such as the intensity of the digital program, patient participation levels, and whether the digital therapy was used in addition to or instead of traditional care are likely to have influenced its effectiveness. For example, an interactive mobile app with substantial cognitive-behavioural modules may result in larger opioid reductions than a basic text-messaging reminder system. Despite these differences, a recurring theme was the high feasibility of implementing interventions using digital platforms, as well as positive user feedback (Miller-Rosales et al., 2023). In conclusion, findings show that digital treatments can effectively deliver behavioural treatment for OUD in a way that patients find acceptable - though extent of improvement varies.

**Comparison of Previous Literature and Conventional Treatment:**

Overall, the findings are consistent with and extend previous studies on digital health interventions for OUD. Prior studies recognised that digital platforms had the potential to increase access to therapy, but there was a lack of long-term outcome data (Tice et al., 2021). For example, an ICER evidence review in 2020 found that at the time, no definitive trials had shown long-term retention benefits from OUD digital apps, and no long-term outcomes like as employment or overdose reduction had been recorded (Tice et al., 2021). This review builds on that foundation by incorporating more recent clinical trials, some of which demonstrate meaningful short-term improvements in outcomes when digital therapeutics are added to standard treatment. Notably, one randomised the trial found that a 12-week prescription digital therapy combination with buprenorphine significantly boosted opioid abstinence (77% versus 62%) and reduced dropout rates by half as compared to treatment as usual (Maricich et al., 2021). This type of evidence was lacking in previous literature, but it now confirms that, under the right conditions, digital treatments can improve recovery measures. When compared to traditional OUD therapies, digital therapeutics appear to serve a complementing function. Medication-assisted treatment (MAT), which combines opioid agonist or antagonist therapy with counselling, is still the gold standard for OUD and is extremely effective in lowering opioid usage and overdose risk. However, more than half of patients initiating MAT discontinue treatment within 3–6 months (Tice et al., 2021), often due to hurdles in accessing ongoing counselling or support. Traditional behavioural therapy can improve patient retention, but it is resource-intensive and not always available. In this regard, digital treatments are best understood as a novel approach to delivering the psychosocial component of OUD treatment. Rather than replacing established treatments, they mimic and expand upon them. In trials where digital therapy was used as an addition to MAT, patients frequently performed better than those on MAT alone (Maricich et al., 2021), which is similar to the advantage of adding any form of counselling to MAT. In contrast, previous studies in which a digital program was evaluated in place of some face-to-face counselling found that outcomes were nearly similar to standard care,

Demonstrating that a well-designed digital tool can match the efficacy of in-person therapy in the short run. This is illustrated by the FDA's approval of the reSET-O treatment, which was based on data that patients using the digital program achieved abstinence rates and retention comparable to those getting clinician-delivered therapy, as well as improved involvement in some metrics (Tice et al., 2021). The results obtained are also consistent with the broader substance use disorder literature, as digital therapeutics have been shown to be effective not only for OUD but also for other addictions such as nicotine dependence, indicating that technology-based delivery of behavioural treatment can consistently produce positive outcomes across different substance use contexts.[33] In conclusion, digital OUD interventions are most effective when combined with traditional treatment, employing technology to augment proven procedures and broaden their reach rather than completely replacing standard care.

**Clinical and policy implications:**

These tools were found to be most effective when used in conjunction with established treatment, such as buprenorphine or methadone, as well as routine counselling. This is consistent with current treatment guidelines, which emphasize a combination of medication and psychosocial assistance for OUD. Digital treatments can help patients in between clinic sessions by providing CBT-based apps for coping skills and motivation, perhaps lowering recurrence. Their great acceptability shows that even those who are hesitant to seek counselling may use digital technologies. However, physicians should monitor usage because effectiveness is dependent on consistent participation. On a broader level, DTx can assist overcome structural hurdles in OUD care, particularly for patients in rural or impoverished locations with limited access to experts (Miller-Rosales et al., 2023). During the COVID-19 pandemic, there was an extraordinary example of this: the rapid expansion of telemedicine allowed patients to continue OUD treatment remotely, resulting in outcomes comparable to traditional in-person care (such as buprenorphine retention programs).**[34]** The success of remote OUD care demonstrates that many treatment features can be efficiently administered from a distance. Digital solutions, such as applications and online platforms, can help to broaden access by providing therapy, Education, and support via smartphone. This is especially useful for patients in remote places, those with little time or childcare, and those who face stigma. Health systems should think about incorporating digital options to extend reach and lower barriers. Realizing these benefits will necessitate supportive policies and cautious implementation. Notably, current adoption of OUD digital health tools by treatment providers remains limited - according to a recent survey of U.S. healthcare organizations, only about 34% had deployed any digital technologies for OUD care, and those that did typically treated these tools as complements to their existing offerings (Miller-Rosales et al., 2023).This suggests that without incentives or guidance, many clinics (particularly those with limited resources) may be hesitant to adopt digital therapies. Policymakers should explore creating frameworks to support the adoption of evidence-based digital solutions. Equity is vital while applying digital treatments for OUD. Without care, these tools may mainly assist tech-savvy, well-connected patients, resulting in wider disparities. To avoid this, rollouts should include support such as providing devices, offering low-bandwidth (SMS) options, and ensuring cultural and language diversity. Successfully integrating DTx into mainstream care will necessitate integrated policies, infrastructure, and equity-focused planning, ultimately enhancing access, retention, and results for various demographics.

**Strengths and limitations:**

This review provides a comprehensive overview of digital therapies (DTx) for opioid use disorder, including various tools, outcomes, and study designs. Key strengths include the utilization of various intervention modalities (e.g., applications, telehealth, web platforms), a focus on patient-centered goals such as usability and satisfaction, and a rigorous, systematic methodology. However, there are numerous constraints to consider. The majority of included research were conducted in countries with high incomes, primarily the United States, which limits worldwide generalizability. Diverse populations, including those in low- and middle-income households, rural communities, teenagers, and those involved in the criminal justice system, continue to be under-represented. The majority of studies only looked at short-term outcomes, so it's uncertain whether these benefits persist.

Because of the rapid advancement of digital health tools, this review may have missed out on newer or updated interventions. Finally, significant publication bias towards study with positive outcomes could have influenced the overall results. Future research should fill these gaps by examining long-term clinical and quality-of-life outcomes, enhancing engagement strategies, comparing intervention formats, testing future technologies such as AI or VR, and determining cost-effectiveness to inform long-term implementation.

## Conclusion

In conclusion, digital therapies are a new addition to OUD therapy resources that has shown promising outcomes in enhancing abstinence and expanding care to more individuals. This review's findings validate their potential while emphasizing need for further exploration. Continued study, particularly in long-term and diverse situations, will assist identify how to best use these devices. With careful integration into health systems and supportive policies, digital therapeutics have potential to significantly improve management of opioid use disorder, providing scalable, accessible support in addition to medication treatment and, ultimately, improving outcomes for those suffering from OUD.

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