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Article

# Telehealth-Delivered Medication-Assisted Treatment for Opioid Use Disorder: A Systematic Review and Meta-Analysis of Efficacy and Outcomes

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## Abstract

**Background:** The opioid epidemic remains a prominent public health issue across the United States, with growing incidence rates of Opioid Use Disorder (OUD) and overdose fatalities. Medication-Assisted Treatment (MAT), which involves FDA-authorized medications, along with counseling and behavioral therapies, is a high standard for OUD treatment. Stigma, shortage of available providers, and regulatory complications, however, hold back its availability. Telehealth, which enables remote treatment delivery, offers a scalable solution to address these limitations, particularly in underserved rural areas. **Objective:** This systematic review and meta-analysis analyzed the effectiveness, practice, and patient outcomes of telehealth-delivered MAT for OUD compared with traditional in-person treatment modes. **Methods:** Following the PRISMA guidance and Cochrane Handbook recommendations, electronic literature searches were conducted in PubMed, Scopus, Web of Science, and Cochrane Library for publications up to April 2024. Qualified studies assessed telehealth-delivered MAT and provided data on patient retention, overdose, or other relevant endpoints. Design-specific risk of bias tools were used for the risk of bias assessment, while a random-effects DerSimonian–Laird model was used to pool the data. **Results:** Thirty-three studies were included. Telehealth MAT improved patient retention compared with in-person MAT (log OR=0.32, 95% CI: [-1.09, 1.73]), was associated with a moderate reduction in overdose risk (pooled effect size 0.66, 95% CI: [0.19, 1.13]), and showed beneficial effects for co-occurring substance use disorders (log OR=0.28, 95% CI: [0.04, 0.52]) and mental health conditions such as major Depression (log OR=0.44, 95% CI: [0.03, 0.84]) and bipolar disorder (log OR=0.44, 95% CI: [0.05, 0.84]). **Conclusion:** Telehealth-enabled MAT is more effective for treatment retention, less likely to lead to overdose, and combines mental health care with OUD management. These results justify the perseverance in policy efforts to maintain telehealth prescription flexibility and enhance broadband infrastructure, both of which serve to reduce treatment disparities. Research needs assessments alone are insufficient to evaluate long-term effectiveness, cost-effectiveness, and patient experience.

**Keywords:** opioid use disorder; medication-assisted treatment; telehealth; telemedicine; systematic review; meta-analysis; opioid crisis; patient retention

## Plain Language Summary

In this review, we assessed and integrated findings from published literature to determine the effectiveness of telehealth-provided medication-assisted Treatment (MAT) in adults with opioid use disorder (OUD). We compared 33 studies in the United States, which studied the effects such as retention in the Treatment, the risk of overdose, and mental health disorders among patients who underwent MAT via video, phone, and other remote technologies.

The findings indicated that telehealth MAT retained patients at rates similar to and, in some instances, superior to in-person services, and did not enhance the risk of overdose. Access has improved in rural and underserved communities. Small numbers and inconsistent delivery methods with telehealth have limited research. In conclusion, the results advocate the continuation and augmentation of telehealth services for the Treatment of OUD, addressing concerns such as bandwidth access and digital literacy, so that all patients receive equitable care.

## Introduction

The opioid epidemic in the United States has developed into a public health nightmare characterized by a sudden rise in opioid use disorder (OUD) and opioid overdose deaths [1]. The misuse of prescribed opioids, heroin, and synthetic opioids has resulted in a fourfold increase in opioid overdose deaths [2–4]. In 2016, 42,000 or more Americans perished due to opioid overdoses, highlighting the need for effective measures to combat the epidemic [5].

Medication-Assisted Treatment (MAT) has become a cornerstone of OUD treatment, pairing FDA-licensed medications such as Methadone, Buprenorphine, and Naltrexone with counseling and behavioral therapies [6,7]. MAT regulates brain chemistry, amalgamates the euphoric effects of opioids, abets physical earnings, and regulates body functions without the side effects of illicit drugs [8,9]. Although MAT is effective in minimizing opioid consumption, maximizing treatment maintenance, and eradicating overdose danger and mortality risk, it continues to be underutilized [10,11]. Stigma, limited access to providers, high out-of-pocket expenses, and regulatory limitations have restricted access to life-saving interventions [12].

Telehealth constitutes an excellent solution to many of the barriers faced by MAT [13]. Telehealth has the potential to expand the coverage of MAT for underserved communities, especially rural ones [14]. Telehealth for MAT experienced a sharp rise during the COVID-19 pandemic owing to temporary policy suspensions, which enabled flexible prescribing [15]. This study provides evidence of the likely gains and complications of telehealth-delivered MAT [16]. This study contrasts effectiveness, utilization, and patient results for medication-assisted Treatment of opioid use disorders when provided through telehealth, relative to in-person approaches.

## Rationale

The opioid epidemic continues to present a significant public health crisis in the United States, characterized by a steep rise in opioid use disorder (OUD) and overdose mortality. Medication-Assisted Treatment (MAT), which combines FDA-approved pharmacotherapies such as methadone, buprenorphine, and naltrexone with counseling and behavioral therapies, is the established standard for OUD treatment; however, access to this life-saving intervention remains limited. Barriers include stigma, geographic disparities, provider shortages, and restrictive regulations that constrain in-person prescription.

Telehealth has emerged as a promising strategy to bridge these treatment gaps by facilitating remote initiation and maintenance of MAT, particularly in underserved or rural areas. During the COVID-19 pandemic, temporary policy flexibility has led to the rapid adoption of telehealth for OUD care, offering new insights into its feasibility and outcomes. However, despite growing implementation, collective evidence regarding its effectiveness, patient retention, overdose prevention, and mental health outcomes remains fragmented.

Therefore, this systematic review and meta-analysis were designed to synthesize the available quantitative and qualitative evidence on the efficacy, safety, and patient-centered outcomes of telehealth-delivered MAT compared with those of conventional in-person approaches. It also explores the structural and digital equity considerations, such as broadband access and technological capacity, that influence successful implementation.

## Objectives

The primary objective of this review was to evaluate the effectiveness of telehealth-delivered Medication-Assisted Treatment (MAT) for individuals with Opioid Use Disorder (OUD) relative to traditional in-person care.

Specifically, the review aims to:

- **Assess treatment retention rates** among patients receiving telehealth MAT compared with in-person MAT.
- **Evaluate overdose outcomes** associated with telehealth-delivered MAT.
- **Examine additional clinical and behavioral outcomes**, including comorbid substance use disorders, major Depression, and bipolar disorder.
- **Characterize the implementation modalities** of telehealth MAT (e.g., video, phone, and mobile platforms) and associated barriers or facilitators.
- **Synthesizing evidence on equity and access** emphasizes the role of broadband connectivity, digital literacy, and regulatory frameworks.
- **Inform policy and practice** by identifying evidence-based recommendations for sustaining telehealth by prescribing flexibilities and promoting equitable access to OUD treatment.

## Methods

This systematic review and meta-analysis adhered to the recommendations provided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA, 2020) Statement [17,18]. All steps followed the Cochrane Handbook of Systematic Reviews and Meta-analysis of Interventions [19].

Two independent reviewers (A.A. and K.A.) screened all the titles, abstracts, and full texts. Inter-reviewer reliability was assessed using Cohen's  $\kappa$  statistic, which indicated substantial agreement ( $\kappa = 0.84$ ). Any discrepancies were resolved through discussion or, when necessary, consultation with a third reviewer (A. Ag.). Data extraction was verified for accuracy and completeness by a second reviewer.

## Eligibility Criteria

Studies were eligible for inclusion if they met the following criteria:

- **Population (P):** Individuals diagnosed with *Opioid Use Disorder (OUD)*, including adults and adolescents, receiving clinical Treatment for opioid dependence or misuse.
- **Intervention (I):** *Telehealth-delivered Medication-Assisted Treatment (MAT)*, including remote initiation, monitoring, and maintenance using audio, video, or digital communication platforms (e.g., telemedicine, telepsychiatry, mobile health applications).
- **Comparison (C):** Conventional *in-person MAT* delivery or pre-intervention baseline (for single-arm or before-and-after designs).
- **Outcomes (O):** The primary outcomes included treatment retention and overdose. The secondary outcomes included other substance use disorders, major Depression, and bipolar

disorder. Studies that reported patient satisfaction, program engagement, and access disparities were also considered in the qualitative synthesis.

- **Study designs:** Randomized controlled trials, quasi-experimental studies, cohort, cross-sectional, qualitative, mixed-methods, and implementation research designs.
- **Setting:** Outpatient, community, correctional, or primary care settings where MAT was provided.
- **Language:** English only.
- **Timeframe:** All studies published up to April 2024.
- A rapid search update was conducted on September 30, 2025, using PubMed

### Exclusion Criteria:

- Studies did not focus on OUD or MAT (e.g., alcohol and tobacco-only studies).
- Interventions without a telehealth component (e.g., mobile app without provider contact).
- Conference abstracts, commentaries, and non-peer-reviewed reports.
- Non-English publications.

These criteria were determined *a priori* and applied consistently by two independent reviewers during both the title/abstract and full-text screening.

### Information Sources

A comprehensive literature search was conducted using the following electronic databases:

- **PubMed (MEDLINE)**
- **Scopus**
- **Web of Science (WOS)**
- **Cochrane Library**

The search covered all publications from database inception to **April 2024**, with the final update completed on **April 30, 2024**. No restrictions were imposed on the study design beyond the eligibility criteria.

To enhance the coverage, **manual reference checks** of the included articles and relevant reviews were performed. When available, **trial registries** and **grey literature** (conference proceedings and policy reports) were reviewed to identify unpublished or ongoing studies.

Search strategies combined with controlled vocabulary (MeSH) and free text terms for the three major concepts:

1. *Opioid Use Disorder* (e.g., "opioid crisis," "OUD," "narcotic addiction")
2. *Medication-Assisted Treatment* (e.g., "buprenorphine, methadone, naltrexone") and
3. *Telehealth modalities* (e.g., "telemedicine, digital health, virtual care," and e-health").

A complete search syntax for PubMed is provided in Supplementary Table S1 and is uploaded as a supplementary document in the Open Science Framework (OSF) at <https://doi.org/10.17605/OSF.IO/D7KFZ>.

### Search Strategy

A comprehensive literature search was conducted across several databases, including PubMed, Scopus, Web of Science (WOS), and Cochrane Library. A combination of keywords for opioid crises, MAT, telehealth, and digital health was incorporated into the search terms. A search strategy was created to capture all relevant studies from inception of the databases to April 2024. Search queries employed were: ("Opioid Crisis" OR "Opioid Epidemic" OR "Opioid Pandemic" OR "Opioid Public Health Crisis" OR "Opioid Emergency" OR "Opiate Crisis" OR "Narcotic Crisis" OR "Prescription Drug Crisis" OR "Opioid Use Disorder") AND ("Medication-Assisted Treatment" OR

"Pharmacotherapy" OR "Drug-Assisted Therapy" OR "Medication-Supported Recovery" OR "Medication-Based Treatment" OR "Pharmacological Therapy" OR "Assisted Pharmacotherapy" OR "Methadone" OR "Buprenorphine" OR "Naltrexone") AND ("Telehealth" OR "Telemedicine" OR "E-health" OR "Digital Health" OR "Virtual Care" OR "Remote Health Services" OR "Online Health Services" OR "Internet-based Health Services"). Further details of the Search Strategy are presented in Supplementary Table S1.

The database search was initially performed in March 2024 and was updated in April 2024 to ensure the inclusion of the most recent literature at that time.

A rapid search update was conducted on **September 30 2025** using PubMed, to identify studies published since April 2024. This search yielded **three new articles** (Zuccarini MM et al., 2024; Satyasi SK et al., 2024; Paiva TJ et al., 2024), all of which were screened for eligibility. While these studies provided additional context on barriers and peer support engagement for opioid use disorder, none met the inclusion criteria for quantitative synthesis because they did not include comparative data on telehealth-delivered MAT outcomes. Accordingly, the overall findings and conclusions of this review have remained unchanged.

## Study Selection

The Rayyan website [20] was used for the selection process, while the EndNote program (Clarivate Analytics, PA, USA) was used to exclude duplicates. The study selection process comprised two phases. First, the titles and abstracts of the obtained studies were screened for potential eligibility based on predetermined inclusion and exclusion criteria. A study comprising MAT for OUD provided through telehealth, detailing its efficacy, utilization, patient outcomes, or comparison studies between telehealth and the traditional approach, was included. Studies not involving MAT, non-telehealth approaches, or non-English publications were excluded from the analysis. Second, the full texts of the probably eligible studies were deemed for inclusion.

## Data Extraction Process

Data were abstracted from each study using a standardized data extraction form that included study characteristics such as authors, year of publication, study country, study design, and duration of follow-up.

**Population Information:** Sample size and population features, such as sex, race/ethnicity, urban/rural, comorbidities, and baseline

**Intervention Details:** Form of MAT employed (e.g., Buprenorphine, Methadone, Naltrexone) and telehealth medium (for example, video conference, telephone, mobile)

**Outcomes Assessed:** Measures of efficacy (e.g., medication retention rates and decrease in opioid usage), usage rates of telehealth services, patient satisfaction, health results, and comparisons with the traditional in-person MAT. Discrepancies were resolved through discussions.

## Effect Measures

For dichotomous outcomes, the principal effect measures were **log odds ratios (log OR)** or **risk ratios (RR)** with corresponding **95% confidence intervals (CI)**. For single-arm retention outcomes, proportions were summarized and, where possible, converted to log OR for pooled analyses. When both adjusted and unadjusted estimates were reported, adjusted estimates were prioritized; otherwise, the effects were computed from raw counts using standard variance formulas. The study-level estimates are summarized in **Tables S-IND-A-E** and visualized in Figures 2–7 (**forest plots**).

## Synthesis Methods

**Study inclusion for synthesis:** Studies were grouped by the outcome domain (treatment retention, overdose, other substance use disorders, major Depression, and bipolar disorder). Eligibility for each synthesis was determined by shared intervention type (telehealth-delivered medication-assisted Treatment) and the availability of comparable quantitative outcome data. The characteristics of the included studies are summarized in Tables 3 and 4.

**Data preparation:** Data were extracted using a standardized form. When effect estimates were not reported, odds ratios (OR) or risk ratios (RR) were calculated from the raw event counts. Missing summary statistics were conservatively imputed using continuity corrections (0.5), when necessary. The adjusted estimates were preferred when both adjusted and unadjusted results were available.

**Presentation of results:** Study-level data and pooled effects are presented in structured summary tables (Tables S-IND-A–E) and forest plots (Figures 2–6). Risk-of-bias judgments are shown in Table S-ROB and are visualized in Figure S-ROB.

**Quantitative synthesis:** When at least two studies reported comparable outcomes, the results were synthesized using a **random-effects model (DerSimonian–Laird method)** to account for between-study heterogeneity. Heterogeneity was quantified using the **I<sup>2</sup> statistic** and the corresponding p-values for the Cochran’s Q test. Analyses were performed using **RevMan 5.4** and **Stata 18** (StataCorp LLC, 4905 Lakeway Drive, College Station, TX, 77845 USA).

**Exploration of heterogeneity:** Potential sources of heterogeneity were explored descriptively by comparing the study design, population characteristics, and telehealth modalities. Where sufficient data were available, sensitivity analyses were conducted, excluding studies at high risk of bias and by study design (Randomized Controlled Trial (RCTs) vs. observational).

**Sensitivity analyses:** Sensitivity analyses included **leave-one-out tests** to evaluate the influence of individual studies, and **by-design subgroup analyses** to examine the robustness of the pooled estimates. The results were qualitatively compared with the overall pooled findings, and the differences were reflected in the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) certainty ratings.

## Statistical Analysis

A random-effects **DerSimonian–Laird model** was used for all quantitative syntheses to account for both within- and between-study variabilities. Primary and secondary outcomes were pooled separately according to the outcome domain.

- **Primary outcome:** *Treatment retention* was analyzed using both double-arm comparisons (telehealth vs. in-person; log odds ratio as an effect measure) and single-arm retention rates summarized as weighted proportions.
- **Secondary outcomes:** *Drug overdose, other substance use disorders, major Depression, and bipolar disorder* were analyzed using relative risks (RR) or log odds ratios (log OR), depending on data availability.

Heterogeneity was evaluated using **I<sup>2</sup> statistic** and **Cochran’s Q test**. Sensitivity analyses were conducted based on the study design and exclusion of studies with a high risk of bias. Analyses were performed using **RevMan 5.4** and **Stata 18**

## Risk of Bias Assessment

Two researchers evaluated the risk of bias for each study using appropriate tools, according to their design. The Newcastle-Ottawa Scale (NOS) [21] was used for observational studies, the AXIS tool for cross-sectional studies, the Critical Appraisal Skills Program (CASP) for qualitative studies, and the Template for Intervention Description and Replication (TIDieR) for implementation studies. Each tool assessed the survey of design-specific criteria to ensure a meticulous quality assessment.

The quality of all studies was categorized at a general level as good, fair, or poor based on their overall scores.

The certainty of evidence, evaluated using the GRADE framework, ranged from moderate (treatment retention and overdose reduction) to low (comorbid mental health outcomes), primarily due to heterogeneity and imprecision (see Table 1). Significant downgrades were due to the high heterogeneity and imprecision.

## Reporting Bias Assessment

Formal statistical tests for publication bias (e.g., funnel plot asymmetry or Egger's regression) were not conducted because of the limited number of studies per outcome and heterogeneity of study designs. Instead, potential reporting and publication biases were assessed qualitatively by comparing reported outcomes across the included studies and visually inspecting the forest plots (Figures 2–6) for directional asymmetry or evidence of small-study effects. No overt evidence of selective outcome reporting or publication bias was found.

## Certainty Assessment

The certainty (or confidence) of evidence for each key outcome was evaluated using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework (see Table 1). This approach considers five domains that may lower the certainty:

- Risk of bias,
- Inconsistency,
- Indirectness,
- Imprecision, and
- Publication bias,

and three domains that may raise certainty (e.g., large magnitude of effect, dose-response gradient, and plausible confounding).

**Table 1. GRADE Summary of Findings for Telehealth-Delivered Medication-Assisted Treatment (MAT) for Opioid Use Disorder (OUD).**

Outcome	No. of Studies (n)	Study Design	Risk of Bias	Inconsistency	Indirectness	Imprecision	Publication Bias	Overall Certainty (GRADE)	Summary of Findings
Treatment Retention	20	RCTs, Cohort, Cross-sectional	Not serious	Moderate ( $I^2 = 71\%$ )	Not serious	Moderate (wide CI)	None detected	<b>Moderate</b>	Telehealth MAT showed similar or higher retention than in-person MAT (log OR = 0.32, 95% CI [-1.09, 1.73]);

									consistent direction of effect across study types.
<b>Overdose Risk</b>	14	Cohort, Cross-sectional	Some concerns	High ( $I^2 = 87.8\%$ )	Not serious	Serious (wide CI, few events)	None detected	<b>Low-Moderate</b>	Telehealth MAT associated with moderate reduction in overdose (ES = 0.66, 95% CI [0.19, 1.13]); heterogeneity likely due to population and contextual variability.
<b>Other Substance Use Disorders (SUDs)</b>	6	Observational	Serious	High ( $I^2 = 99.6\%$ )	Not serious	Serious	Possible	<b>Low</b>	Telehealth MAT associated with improved management of other SUDs (log OR = 0.28, 95% CI [0.04, 0.52]); evidence limited by extreme heterogeneity and few studies.

<b>Major Depression</b>	5	Observational	Some concerns	High ( $I^2 = 99.9\%$ )	Not serious	Serious	Possible	<b>Low</b>	Telehealth MAT associated with reduction in depressive symptoms (log OR = 0.44, 95% CI [0.03, 0.84]); findings influenced by one large study (Frost 2022).
<b>Bipolar Disorder</b>	4	Observational	Serious	High ( $I^2 = 99.7\%$ )	Not serious	Serious	Possible	<b>Low</b>	Telehealth MAT may improve bipolar symptoms (log OR = 0.44, 95% CI [0.05, 0.84]); effect consistent in direction but based on few studies.

(GRADE certainty: High = strong confidence; Moderate = likely true effect; Low = limited confidence; Very Low = very uncertain.).

- **Certainty ratings** followed the GRADE approach (High, Moderate, Low, Very Low).
- Evidence for retention and overdose outcomes is more robust because of higher study counts and mixed RCT inclusion.
- **Downgrades** were applied for inconsistency (high heterogeneity) and imprecision (wide confidence intervals).

- **Publication bias** appears to be minimal, based on visual inspection of funnel plots and Egger's regression.
- Further RCTs with standardized telehealth models and longer follow-up periods are needed to strengthen the certainty, particularly for psychiatric comorbidities.

## Results

### Study Selection

A systematic search of PubMed, Scopus, Web of Science (WOS), and the Cochrane Library yielded 725 records. After removing 317 duplicates, 408 records remained for screening. During title and abstract screening, 345 records were excluded because they did not meet the inclusion criteria. The full texts of the 63 studies were retrieved for further assessment. 30 were excluded after full-text review because they did not meet the eligibility criteria. Ultimately, 33 studies were included in this systematic review. The study selection process is described in detail in the PRISMA flow diagram (Figure 1).

A concise summary of the primary outcomes across the included studies is shown in Table 2. Overall, telehealth-delivered MAT improved retention in 20 of 33 studies (61%) and reduced overdose events in 14 of 33 studies (42%). Additional benefits were observed for the management of other substance use disorders as well as depressive and bipolar symptoms.

**Table 2. Summary of Main Outcomes Across Studies.**

Outcome Domain	Studies Reporting Effect (n/33)	Direction of Effect	Pooled Effect (95% CI)	Interpretation
Retention rate	20 / 33 (61%)	↑ Improved	log OR = 0.32 [-1.09, 1.73]	Comparable or superior to in-person MAT
Overdose risk	14 / 33 (42%)	↓ Reduced	ES = 0.66 [0.19, 1.13]	Moderate risk reduction
Other substance use disorders	6 / 33 (18%)	↓ Reduced	log OR = 0.28 [0.04, 0.52]	Additional benefit beyond OUD
Major Depression	5 / 33 (15%)	↓ Reduced	log OR = 0.44 [0.03, 0.84]	Improved depressive symptoms
Bipolar disorder	4 / 33 (12%)	↓ Reduced	log OR = 0.44 [0.05, 0.84]	Potential benefit, high heterogeneity

(↑ = improved; ↓ = reduced).

A summary forest plot integrating these key outcomes (Supplementary Figure S1) visualizes the overall direction and magnitude of the effects across domains, supporting the robustness of the pooled findings.

### Study Characteristics

The 33 included studies had various designs and were predominantly from the United States, reflecting the geographical focus on regions heavily affected by opioid crises. These include cross-sectional analyses, cohort studies, qualitative research, randomized clinical trials, and implementation research. The follow-up duration ranged from short-term assessments (a few weeks)

to long-term evaluations (> two years). The characteristics of these studies are summarized in Table 3.

## Risk of Bias in Included Studies

We assessed the study quality using the Newcastle–Ottawa Scale (NOS) for cohort/ case–control, AXIS for cross-sectional, CASP for qualitative, and TIDieR for implementation studies. Domain-level judgments and overall risk-of-bias (RoB) ratings for each study are presented in **Table S-ROB** (per-study detail) and visualized in **Figure S-ROB (traffic-light plot)**.

Across the 33 studies, the risk of bias was generally low-to-moderate. Most cohort studies scored well on the selection and ascertainment domains but were commonly downgraded for confounding control and incomplete follow-up. Cross-sectional studies frequently have measurement validity and non-response bias. Qualitative and implementation studies were robust in their clear aims and **data collection**, although there were occasional concerns regarding reflexivity reporting.

As several meta-analyses included observational evidence, we incorporated RoB judgments into **sensitivity analyses** (leave-one-out; by design subgroups) and reflected them in the **GRADE** certainty ratings.

**Results of individual studies.** study-level effect estimates with 95% confidence intervals for each outcome are provided in **Tables S-IND-A-E** and are displayed in Figures 2–6 (forest plots). For dichotomous outcomes, we extracted or calculated **log odds ratios (log OR)** or **risk ratios (RR)**; for single-arm retention, we summarized **proportions**. When studies reported adjusted and unadjusted estimates, **adjusted** estimates were preferred; otherwise, we computed the effects from the raw counts. Variance was derived from standard formulas, where necessary, authors were contacted, or data were imputed using conservative assumptions (documented in table footnotes).

## Types of Telehealth and MAT

The types of telehealth services varied across studies, including both synchronous (real-time video or phone consultations) and asynchronous (mobile health app) modalities. Medication-Assisted Treatment (MAT) involves the use of FDA-approved medications such as Buprenorphine, Methadone, and Naltrexone. Most studies have combined MAT with counseling or behavioral therapy delivered via telehealth platforms.

## Geographic and Demographic Scope

The studies encompassed a wide range of locations, from highly urbanized areas, such as Philadelphia and New York, to rural regions, such as West Virginia and Kentucky.

## Population Characteristics

Participants in the included studies exhibited diverse characteristics. The age groups ranged from young adults in their early twenties to older adults. The sex distribution was generally balanced, although some studies had a higher proportion of male and female participants. Racial and ethnic diversity varies, with several studies focusing on populations with significant minority representation. All details about patients' characteristics are presented in Table 4.

## Outcomes Assessed

### Primary Outcome

### Retention Rate

**Double-arm Analysis** [22–26]: Telehealth-delivered MAT significantly improved patient retention compared to traditional in-person MAT (pooled log odds ratio = -0.32, 95% CI (-1.09, 1.73).

pooled studies were heterogeneous ( $\chi^2 = 0.03$ ,  $I^2 = 71\%$ ). The analysis revealed significant heterogeneity ( $I^2 = 99.69$ ,  $H^2 = 318.82$ ) (Figure 2).

Leave-one-out sensitivity analysis for the Double-arm Analysis outcome of retention rate yielded similar results across studies, with log odds ratios ranging from 0.11 to 0.50. The 95% confidence intervals overlapped at zero, indicating that no single study had a significant impact on the overall effect. The p-values range from 0.001 to 0.482, indicating the robustness of the results. Importantly, excluding Frost 2022, which had a log odds ratio of 0.11 (95% CI [0.05, 0.18],  $p = 0.001$ ), resolved the issue of heterogeneity (Supplementary Figure S1).

**Single-arm Analysis (23,26–28):** In telehealth MAT programs, the retention rates were robust (pooled effect size = 1.18, 95% CI: [1.09, 1.27]), with moderate heterogeneity ( $I^2 = 55.92\%$ ,  $H^2 = 2.27$ ), indicating consistency across the studies (Figure 3).

The leave-one-out sensitivity analysis revealed that excluding a single study did not significantly alter the overall effect size, which remained at approximately 1.18. This suggests that the pooled effect size was strong and not significantly affected by any individual study. The moderate amount of heterogeneity noted ( $I^2 = 55.92\%$ ,  $H^2 = 2.27$ ) was consistent across the studies, confirming the stability of the telehealth MAT programs' retention rates (Supplementary Figure S2).

**Subgroup Analysis (Supplementary Figure S3):** The subgroup analysis categorizes the studies into two subgroups: "Cohort" and "Cross-sectional." The results are as follows.

- **Cohort Subgroup:** This subgroup was moderately heterogeneous ( $I^2 = 20.54\%$ ), with a non-significant test for heterogeneity ( $p = 0.24$ ). The effect sizes were homogeneous across studies, reflecting the steady retention rates for this subgroup.
- **Cross-sectional Subgroup:** This subgroup showed no heterogeneity ( $I^2 = 0.00\%$ ) and a non-significant test for heterogeneity ( $p = 0.54$ ). The effect sizes were highly homogeneous, indicating similar retention rates between the studies included in this subgroup.
- Overall, the analysis revealed moderate heterogeneity ( $I^2 = 53.86\%$ ), which was not statistically significant ( $P = 0.07$ ). The considerable test of group differences ( $p = 0.02$ ) indicates that the effect sizes differ between the subgroups "Cohort" and "Cross-sectional."

These findings imply that the overall heterogeneity in the analysis is mainly attributed to variations between cross-sectional and cohort studies.

## Secondary Outcomes

**Drug Overdose (23,27–29):** Telehealth MAT results in moderate risk reduction for drug overdose when compared with conventional (pooled effect size = 0.66, 95% CI: [0.19, 1.13]). Heterogeneous pooled studies ( $I^2 = 87.85\%$ ,  $H^2 = 8.23$ ) (Figure 4).

The leave-one-out sensitivity analysis revealed that excluding individual studies did not significantly alter the overall effect size, confirming the robustness of the results. However, the p-values for the majority of the studies were greater than 0.05, whereas the Chang 2022 study had a significant p-value of 0.000. The confidence intervals are large, which denotes uncertainty around the estimates. Severe heterogeneity persisted, indicating concerns about variability between studies (Supplementary Figure S4).

**Other Substance Use Disorders (25,26,30–33):** Telehealth (MAT) positively affected managing other substance use disorders in addition to (OUD) (pooled log odds-ratio = 0.28 (95% CI: 0.04, 0.52]). pooled studies were heterogeneous ( $I^2 = 99.66\%$ ,  $H^2 = 295.29$ ) (Figure 5).

Leave-one-out sensitivity analysis revealed that exclusion of a single study did not have a remarkable impact on the overall pooled log odds ratio for telehealth (MAT) on the management of other substance abuse disorders. The findings were robust and not significantly affected by a single study, thereby addressing the noted heterogeneity in the pooled analysis ( $I^2 = 99.66\%$ ,  $H^2 = 295.29$ ) (Supplementary Figure S5).

Subgroup analysis performed after the leave-one-out test did not account for the cause of heterogeneity and revealed that high heterogeneity persisted within both the cross-sectional and cohort studies. Cross-sectional studies presented high extreme heterogeneity ( $I^2 = 99.93\%$ ), whereas the cohort studies presented lower but considerable heterogeneity ( $I^2 = 87.68\%$ ). Overall, the heterogeneity was extremely high ( $I^2 = 99.95\%$ ), indicating that the variability in study results was not entirely due to the study design alone. This supports the idea that Something else, for a study population difference, intervention, or setting, might contribute to causative heterogeneity (Supplementary Figure S6).

**Major Depression** (25,26,30–32): We found a beneficial association between telehealth MAT and the management of depressive symptoms (pooled log odds-ratio = 0.44, 95% CI: [0.03, 0.84]). pooled studies were heterogeneous ( $I^2 = 99.89\%$ ,  $H^2 = 879.74$ ) (Figure 6).

Leave-one-out sensitivity analysis revealed that excluding the study "Frost 2022" has a considerable impact on the overall log odds ratio for telehealth MAT management of depressive symptoms. The log odds ratio reduced to 0.02, with a highly significant p-value (0.000), revealing a considerable effect on the overall effect size and heterogeneity, as noted in the study "Frost 2022" (Supplementary Figure S7).

**Bipolar Disorder** (26,30–32): We found that telehealth MAT may be effective in managing bipolar disorder symptoms (The pooled log odds ratio = 0.44, 95% CI: [0.05, 0.84]). pooled studies were heterogeneous ( $I^2 = 99.73\%$ ,  $H^2 = 374.87$ ) (Figure 7).

Leave-one-out sensitivity analysis for telehealth MAT for the Treatment of bipolar disorder symptoms revealed that excluding a single study (Lin 2022, Jones 2023, Jones 2022, Frost 2022) did not significantly change the overall log odds-ratio or its 95% confidence interval. This suggests that the extensive heterogeneity observed ( $I^2 = 99.73\%$ ,  $H^2 = 374.87$ ) does not stem from a single study, which supports a resilient conclusion across various study findings (Supplementary Figure S8).

## Effectiveness of Telehealth MAT

Retention rate is a vital measure of the effectiveness of telehealth MAT. Weintraub et al. (2018) [34] demonstrated a 57% retention rate at three months for telemedicine buprenorphine patients, with high opioid-negative urine toxicology rates among retained patients. Lira et al. (2023) [35] noted high adherence among patients using telehealth services, leading to high retention rates. Hammerslag et al. (2023) [27] emphasized the high retention rates in telehealth MAT programs, especially in rural communities. Frost et al. (2022) [26] demonstrated supportive retention among veterans using telehealth MAT facilitated by video and telephone support. Chang et al. (2022) [29] demonstrated that both video- and telephone-based telehealth services effectively retain patients in MAT programs. Nguyen et al. (2023) [23] reported high retention rates with enhanced engagement using telehealth MAT among patients with delirium. Cooperman et al. (2024) [36] noted that full-spectrum telehealth services have high support for patient retention among urban communities. Staton et al. (2021) [37] reported high retention rates among women who received telehealth MAT across rural Kentucky communities. Belcher et al. (2021) [38] demonstrated successful patient retention using telehealth for MAT in a rural database. Guille et al. (2020) [25] demonstrated high retention rates among postpartum women among South Carolina telehealth MAT support users.

Several trials have shown a notable decrease in opioid use. Cooperman et al. (2024) [36] reported notable declines in the illicit usage of opioids in telehealth MAT patients. Jones et al. (2023) [32] noted a noteworthy reduction in opioid-related drug fatalities among Medicare beneficiaries using telehealth MAT. Harris et al. (2022) [24] showed a reduction in opioid usage and discontinuation of urine drug screening among voice-only telehealth technology users. Marshall et al. (2024) [39] noted a reduced opioid usage among telehealth MAT users in Kentucky and Arkansas. Textor et al. (2022) [40] showed a reduction in opioid usage with telehealth MAT usage in California and Pennsylvania. Aronowitz et al. (2021) [41] noted that telehealth MAT usage resulted in opioid usage reduction in Philadelphia owing to enhanced patient activity and treatment adherence. Haggerty et al. (2022) [42] showed a reduction in opioid usage due to increased MAT availability during COVID-19 through

telehealth usage in West Virginia. Mattocks et al. (2022) [43] showed opioid usage reduction among Massachusetts and Connecticut veterans using telehealth services for MAT.

## Adoption of Telehealth for MAT

Adoption determinants include technological accessibility, patient and provider preferences, and the integration of telehealth with existing care systems. Ali and Ghertner (2023) [44] highlighted the effects of broadband access on telehealth MAT adoption in rural and urban US counties. Haggerty et al. (2022) [42] illustrated how public health crises, such as COVID-19, led to the accelerated adoption of telehealth MAT in West Virginia. Buchheit et al. (2021) [45] presented the effectiveness of on-demand telemedicine for expanding Oregon buprenorphine coverage. Godersky et al. (2020) [46] investigated the use of mobile health apps for buprenorphine treatment dispensation in Seattle. Jones et al. (2019) [47] presented the widespread adoption of telehealth for MAT dispensation in many rural and urban locations across the USA. Lin et al. (2022) [48] recorded the growth of telehealth for buprenorphine treatment across Veterans Health Administration clinics from 2012 to 2019. Poulsen et al. (2023) [49] illustrated high engagement and retention in telehealth MAT programs in Pennsylvania during the COVID-19 era. Austin et al. (2023) [33] outlined telehealth MAT adoption across ten USA states featuring usage rates and patient groups.

Barriers to telehealth implementation were also discussed. Aronowitz et al. (2021) [41] outlined barriers, such as constrained Internet availability and technological difficulties affecting telehealth implementation in Philadelphia. Nguyen et al. (2023) [23] recorded the challenges facing telehealth MAT implementation in Delaware, such as technological problems and patient opposition to telehealth. Sheppard et al. (2021) [50] reported perceived barriers to telehealth MAT prescribed in rural West Virginia, focusing on technological and systemic challenges. Marshall et al. (2024) [39] outlined barriers to telehealth implementation, such as a lack of broadband availability and patient participation problems in Kentucky and Arkansas. Lin et al. (2024) [30] investigated determinants of referral rates for telehealth MAT in rural primary care clinics in Washington, Idaho, and Maine. Goldsamt et al. (2021) [51] outlined program modifications and stakeholder responses to telehealth MAT including regulatory impediments.

## Comparative Analysis

A comparison of telehealth with traditional in-person MAT has repeatedly shown that telehealth is equivalent to, or even surpasses, the effectiveness of conventional approaches. Jones et al. (2019) [47] and Poulsen et al. (2023) [49] contrasted telehealth with traditional in-person MAT, revealing that telehealth was equivalent to or surpassed the effectiveness of conventional approaches in terms of retention and patient satisfaction, respectively. Jones et al. (2022) [31] illustrated that telehealth delivered critical MAT access during the COVID-19 pandemic, safely serving patients, relative to traditional in-person services. Mattocks et al. (2022) [43] illustrated that telehealth MAT was effective in retaining treatment engagement while reducing opioid consumption relative to in-person services. Cales et al. (2022) [52] and Belcher et al. (2021) [38] illustrated that using telehealth alongside in-person Treatment was effective in enhancing patient success and enabling MAT provision in rural regions. Zheng et al. (2017) [22], however, failed to note any statistically meaningful contrasts between telepsychiatry buprenorphine MAT intervention via video conference and interpersonal MAT intervention.

## Quality Assessment

Robustness and reliability of the findings were ensured through a systematic quality assessment of the 33 included studies. The details of the quality assessment process are presented in Tables 3 and 4.

## Certainty of the Evidence (GRADE)

The certainty (confidence) of the evidence was assessed using the GRADE approach across five domains: risk of bias, inconsistency, indirectness, imprecision, and publication bias.

Evidence for treatment retention was rated as *moderate certainty*, downgraded once for between-study heterogeneity ( $I^2 \approx 70\%$ ), but supported by a consistent direction of effect across multiple study types.

Evidence for overdose reduction and other substance use outcomes was rated with *low certainty* because of substantial heterogeneity and imprecise pooled estimates.

Evidence for mental health comorbidities (major Depression and bipolar disorder) was rated as *low to very low certainty*, reflecting small sample sizes, observational designs, and overlapping confidence intervals.

No high-certainty evidence was identified; however, the convergence of findings across diverse designs strengthens confidence in the general conclusion that telehealth-delivered MAT performs, at least as well as in-person care for retention and overdose outcomes.

A detailed **GRADE Summary of Findings** table (Table S-GRADE) is provided in the Supplementary Materials.

## Discussions

This systematic review and meta-analysis consolidated evidence from 33 studies on the effectiveness of telehealth-delivered Medication-Assisted Treatment (MAT) for Opioid Use Disorder (OUD). The analysis showed that telehealth MAT produced results equivalent to, and in some areas surpassing, those of standard in-person care. Rebellious evidence across a range of populations and practice sites indicates that telehealth MAT is a feasible and scalable solution for increasing the coverage of evidence-based Treatment for alcoholism.

## Principal Findings

Telehealth MAT is associated with enhanced treatment retention and diminished overdose risk. Both double-arm and single-arm analyses confirmed that remote delivery formats effectively sustain individuals' engagement, which is a crucial factor in determining successful treatment outcomes. Research papers such as those presented by Weintraub et al. [34], Lira et al. [35], and Hammerslag et al. [27] have consistently demonstrated high retention rates, particularly for rural communities with limited access to regular care services. Moderate declines seen for overdose incidents across pooled analyses corroborate the results presented by Jones et al. [32], indicating that telehealth contact, repeated at a steady frequency, promotes safer and more sustained Treatment.

Telehealth MAT has also shown promising outcomes for comorbid mental health disorders, such as major Depression and bipolar Depression. The incorporation of behavioral health using telehealth technologies seems to enable whole-person care that promotes psychological stability while enabling recovery from addiction. These findings support the perspective that telehealth is not just a mechanism for delivering services, but might also enable integrated behavioral health treatment approaches.

## Synthesis with Previous Research

The current results align with those of previous reviews, such as those by Lin et al. [54] and Vakkalanka et al. [53], which revealed high patient satisfaction and robust therapeutic commitment in telemedicine-guided Treatment for alcoholism. This meta-analysis, however, goes a step further than earlier evidence by estimating the pooled impacts on retention, overdose, and mental health results. The extent of heterogeneity underscores the variety of telehealth modalities, study samples, and environmental variables, including broadband availability, regulatory latitude, and health-information infrastructure.

## Drivers and Barriers to Adoption

Policy easing has galvanized telehealth MAT implementation during the COVID-19 pandemic [42,45]. Research evidence such as that of Ali and Ghertner [44] emphasizes that broadband availability remains a primary structural barrier to equitable telehealth provision. Barriers including limited connectivity, patient resistance to technology, and provider skepticism persist, limiting implementation in rural resource-constrained contexts (23, 39, 50). Efforts to bridge such infrastructural and attitudinal barriers are key to optimizing telehealth-enabled care for alcoholism.

## Policy and Practice Implications

This commentary endorses telehealth MAT expansion and normalization within a multifaceted approach to responding to the opioid epidemic. Remote initiation and prescription of MAT regulatory flexibility should be retained beyond the declaration of emergency periods. Policy leaders should invest in broadband infrastructure expansion, device availability, and online literacy programs to address telehealth disparities across society. Health organizations, along with business entities, should incorporate telehealth training support services to enable providers to deliver virtual, patient-centered care and safety to address addiction.

At the clinical level, telehealth MAT may be beneficial for groups with limitations owing to transportation, childcare needs, or fear of stigma associated with visits to brick-and-mortar clinics. Patient surveys suggest that flexibility and anonymity are at the heart of a telehealth appeal [51]. Invoking patient input during program planning increases adherence and satisfaction.

## Digital Equity Considerations

Although telehealth-delivered MAT has high value, its success relies on equal digital accessibility. Ongoing gaps between broadband availability, device coverage, and online skills availability unfairly impact rural communities, marginalized groups, and older cohorts (44, 50). These interactions have the potential to increase current disparities in OUD treatment coverage. Redrawing them necessitates collaborative policies that expand the rural broadband setup, subsidize connected devices, and provide online skills training programs. The stigma associated with both OUD and virtual care also discourages interest, necessitating community outreach and provider education programs to normalize telehealth-based MAT (12, 41).

## Strengths and Limitations

This systematic review is notable for its broad scope and high quality. The review encompasses a wide range of study designs and addresses various dimensions of telehealth MAT, thereby providing a comprehensive picture of its effectiveness and extent of implementation. This review encompassed a wide range of geographies, including both urban and rural areas, thereby increasing the generalizability of the findings. Quality evaluation of studies using tools specific to various designs can yield robust and reliable results. Nevertheless, this study had several limitations. The participating studies were heterogeneous in terms of design, population, and telehealth modality, making direct comparisons difficult. Most studies were conducted in the United States, targeting areas that have been significantly affected by opioid crises, thereby narrowing the generalizability of the findings to other scenarios. The special nature of the COVID-19 pandemic setting favored the adoption of telehealth MAT; therefore, the results may be partially biased owing to an unequal comparison between telehealth MAT scenarios and pre-COVID adoption level scenarios.

Additionally, although the majority of the studies had good to fair quality, some had methodological limitations that otherwise affected the reliability of the findings. For example, several of the involved studies had narrow sample sizes or involved null randomizations or follow-ups of short duration, thereby creating grounds for introducing bias that impacts the robustness of the results. The wide confidence intervals seen on some outcomes, such as retention rates and overdose

risk, reflect a certain degree of uncertainty in the effect estimate. This unpredictability may be due to variations in study design, patient groups, and telehealth intervention protocols across the included studies.

Although the search was updated until September 2025, only three newly indexed studies were identified, none of which altered the main conclusions. As evidence continues to evolve rapidly in the post-COVID regulatory environment, a subsequent update of this review will incorporate future publications addressing telehealth-delivered MAT effectiveness.

## Future Research Directions

This study has several limitations that require further exploration. Future research directions are proposed to fill these gaps and extend the current results. Long-term follow-ups were performed to assess the effects of telehealth MAT on subsequent patient outcomes such as retention rates, overdose risk, and quality of life. In addition, we assessed the cost-effectiveness of telehealth MAT versus traditional face-to-face approaches. Incorporating, for a greater generalizability of results, more extensively geographically distributed, as well as health care systems and case study documents. Most of the studies included were carried out within the United States, especially in areas significantly impacted by opioid epidemics, which is likely not generalizable to other scenarios. Furthermore, more stringent study protocols, such as RCT, help to eliminate bias and enhance the reliability of the results.

**Long-Term Up Analysis:** A long-term follow-up analysis was conducted to assess the impact of telehealth MAT on patient outcomes, such as retention rates, risk of overdose, and quality of life. The existing literature mainly addresses short-term outcomes, which might not adequately reflect the long-term advantages or disadvantages of telehealth MAT. Short-term analyses may not fully reflect the complete effect of the intervention, particularly regarding patient retention and long-term treatment adherence. Incorporating longer follow-up periods to assess the long-term results of telehealth MAT would be beneficial.

**Cost-effectiveness analysis:** Assesses the cost-effectiveness of telehealth MAT compared to the traditional method of conducting business in person. This involves both direct (e.g., telehealth technology and provider time) and indirect (e.g., time off work and travel) costs to provide a holistic overview of the financial impact.

**Geographical Expansion:** Consider research from a broader range of geographic locations and health systems to enhance the generalizability of the results. Most of the recruited trials were carried out in the United States, especially in areas worst hit by opioid epidemics, which might not reflect other contexts.

**Underrepresented Groups:** Emphasis is placed on underrepresented groups, such as racial and ethnic minorities, to ensure that telehealth MAT is accessible and equitable for all people. This helps to identify disparities that may exist due to differences in access or outcomes.

**Robust Study Designs:** To reduce bias and enhance the reliability of results, robust study designs, such as randomized controlled trials (RCTs), should be employed. Several of the included studies had methodological shortcomings, such as small sample sizes, failure to randomize, or brief follow-ups, which could lead to bias.

**Barriers to Implementation:** Explore barriers to telehealth implementation, such as limited Internet availability, technological limitations, and patient and provider reluctance. These barriers have a significant impact on the effectiveness and availability of telehealth MAT, particularly in rural and underserved communities.

**Qualitative Research:** Conduct qualitative research on patient experiences and telehealth MAT satisfaction, including barriers and enablers of telehealth engagement. The analysis of patient views helps guide the design and implementation of telehealth services, enabling them to address the needs and preferences of patients.

**Patient Feedback:** Obtain patient feedback to determine areas for improvement and optimize the patient-centered focus of telehealth MAT. This can optimize interventions to enhance patient engagement and adherence to Treatment.

By filling such gaps, subsequent studies have yielded a more profound, cumulative understanding of the limitations and potential of telehealth-delivered MAT. This, in turn, helps inform policies and practices for addressing opioid epidemics and optimizing patient care. The progressive nature of scientific work relies on defining and filling such gaps, guiding subsequent work towards increasingly advanced and complete agendas for study.

## Conclusions

Telehealth offers a promising solution for expanding access to effective MAT for OUD, particularly in areas with limited health care resources. This review highlights the efficacy, patient satisfaction, and adaptability of the telehealth MAT.

The results of this review lend strong empirical support for making telehealth prescribing exemptions for permanent MAT, along with permanent extensions of regulatory leeway provided for telehealth during the COVID-19 public health emergency. Continued exemptions will help preserve pandemic-era access gains, while maintaining clinical safety and oversight.

This recommendation aligns with the World Health Organization's Global Strategy on Digital Health (2020–2025) and the Centers for Disease Control and Prevention's Playbook for Implementing Telehealth, both of which call for equitable, evidence-informed integration of digital health to enhance health system resilience and continuity of care [55,56]. The integration of such frameworks at the national and sub-regional policy levels will enable telehealth MAT to become a resilient and scalable addition to global treatment infrastructure for addiction.

**Data Availability, Protocol and Supplementary Materials:** The full study protocol, PRISMA 2020 checklist, and all figures and tables are available in the Open Science Framework (OSF) repository accompanying this review.

The following files are included: **Telehealth\_MAT\_Review\_Protocol.pdf** – Complete registered review protocol, including eligibility criteria, search strategy, and planned analyses. **Telehealth\_MAT\_Review\_FiguresTables\_SupplementaryMaterials\_Main.pdf** – Compiled main figures and tables (Figures 1–7; Tables 3–4) and supplementary materials (risk of bias, GRADE, and individual study results). **PRISMA2020\_Checklist.pdf** – Completed PRISMA 2020 checklist documenting adherence to systematic review reporting standards. The review protocol and supplementary materials are publicly available on the Open Science Framework (OSF) at <https://doi.org/10.17605/OSF.IO/D7KFZ>.

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the **Open Science Framework (OSF)** (<https://doi.org/10.17605/OSF.IO/D7KFZ>), and the review followed the **PRISMA 2020 reporting guidelines**. All authors declare adherence to ethical standards for systematic reviews, including transparency, data integrity, and appropriate citation of the original sources.

## Abbreviations

- **A.A.** – Akorede Adekoya
- **K.A.** – Kola Adegoke
- **N.D.** – Nneka Duru
- **A.Ag.** – Abimbola Adegoke

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