THE MATRIX MODEL FOR THE TREATMENT OF STIMULANT USE DISORDERS

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OHIO SUBSTANCE USE DISORDER

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Executive Summary

Background

The Matrix Model was developed in the 1980s by Rawson and his colleagues at the Matrix Institute as a response to the cocaine epidemic. It stands out as one of the few treatment models designed to address the treatment needs of individuals with stimulant use disorders. The Matrix Model of treatment includes group, individual, and family components, with the group component evolving to address the unique challenges of sobriety as the treatment progresses.

Methods

To understand and assess the effectiveness and utility of the Matrix Model, a literature review was undertaken to investigate the outcomes associated with the model. Twenty-one articles met eligibility criteria for a full review. Reviewed studies varied by design and statistical methodology. Nine studies were experimental, with participants randomly assigned to either the Matrix Model or another form of treatment, or to no treatment. Four studies were quasi-experimental, lacking random assignment of participants, and eight were non-experimental, consisting of observational studies that only included the Matrix Model. Ten studies were conducted in the U.S., nine were conducted in Iran, one in Thailand, and one in South Africa. The outcomes included drug use (e.g., abstinence and reduction in drug use), treatment retention and completion, functioning (e.g., depressive and anxiety symptoms), substance cravings, and other less often examined outcomes such as risky behaviors and physiologic outcomes (e.g., cortisol levels).

Findings

Overall, the findings on the effectiveness of the Matrix Model compared to another type of treatment are mixed. There is strong support for improved outcomes related to drug use and cravings when the Matrix Model is combined with pharmacotherapy and brain stimulation. Other studies of the Matrix Model demonstrated that abstinence or reductions in drug use were associated with baseline drug use severity (i.e., higher severity was associated with reduced drug use at follow-up), in-treatment abstinence, and increased session attendance.

There is limited evidence that the Matrix Model is effective for improving retention and treatment completion outcomes. One study found that Matrix Model participants had significantly higher completion rates compared to a treatment as usual (TAU) group. Another study found that even though the Matrix Model participants attended a higher mean number of sessions than those in a less intensive form of outpatient treatment, there was no statistically significant difference in treatment completion rates. Additionally, a separate study found that participants in a condition where the Matrix Model was supplemented with drug court ("Matrix Model plus drug court") had higher odds of treatment completion compared to participants in a Matrix Model only condition.

Most studies identified improvements in mental health status, such as depression and anxiety symptoms, regardless of treatment condition. Mental health status improvements generally did not differ among those who received the Matrix Model alone, or the Matrix model vs other group treatments, or the Matrix Model augmented with pharmacotherapy, or augmented with a drug court intervention.

Two studies provided support for combining the Matrix Model with other interventions to regulate stress hormones (i.e., the Matrix Model plus oxytocin) or improve cognitive performance. A different study found no differences in risky behaviors between the Matrix Model and TAU groups; however, reductions in risky sexual and injection behaviors were observed when clients in both conditions stayed in treatment for longer periods or completed the treatment.

Conclusion

After reviewing the available evidence published in the peer-reviewed literature to date, the Matrix Model is a promising multi-component treatment model with mixed evidence of treatment effectiveness depending on the type of outcome studied and the related treatment augmentation variations. Adherence and fidelity monitoring reporting was minimal, and eleven studies were conducted outside the United States, including nine in Iran, with distinctly different treatment and cultural contexts. Two evidence-based practice (EBP) registries rated the Matrix Model at the mid-point of their respective rating systems, indicating that there is some support for the effectiveness of the model.

In 2018, the Matrix Institute merged with CLARE Foundation under a new name - CLARE|MATRIX. In September 2023, investigators conducted a benchmarking interview with the CLARE|MATRIX training director to obtain the most recent and updated research information about the Matrix Model. The interview revealed that CLARE|MATRIX does not use the publicly available 2006 Center for Substance Abuse Treatment (CSAT) version of the Matrix Model, which is considered outdated. Instead, they use and provide training on a newer, revised version of the model that integrates motivational interviewing, cognitive-behavioral techniques, and contingency management, as well as retaining twelve-step facilitation (TSF) and family

involvement. Another notable finding was that no research has been published on the revised or population-specific models that CLARE|MATRIX uses. The new *Matrix Model Intensive Outpatient Alcohol and Drug Treatment Program* therapist's manual is not publicly available but can be purchased through Hazelden Publishing.

As is often seen in the development and progression of evidence-based interventions, there are now at least two additional variations of the Matrix Model - one for criminal justice settings and one for teens and young adults. As the Matrix Model has evolved over the past 30 years, the research publications have not examined the most recent iterations to evaluate current treatment effectiveness. Supporting additional research and evaluation on more recent versions and diverse applications of the Matrix Model would help close that gap.

THE MATRIX MODEL FOR THE TREATMENT OF STIMULANT USE DISORDERS

Stimulant Use Disorder Trends in the U.S. and Ohio

Substance misuse poses a significant challenge in the Unites States, particularly with increases in overdose deaths from stimulant use (Ahmad et al., 2023). The term, "stimulants" refers to a class of drugs that includes, "prescription drugs such as amphetamines, methylphenidate, diet aids, and other illicitly used drugs such as methamphetamine, cocaine, methcathinone, and other synthetic cathinones that are commonly sold under the guise of 'bath salts'" that can come in multiple forms, such as, "pills, powders, rocks, and injectable liquids" (U.S. Drug Enforcement Administration [DEA], 2020). While there are important therapeutic and medical uses for stimulants under the guidance and supervision of medical and behavioral health professionals, the misuse of these substances can lead to serious individual and public health consequences (U.S. DEA, 2020). The Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM–5TR) defines stimulant use disorder as, "a pattern of amphetamine-type substance, cocaine, or other stimulant use leading to clinically significant impairment or distress" (American Psychiatric Association [APA], 2022).

The Centers for Disease Control and Prevention's National Vital Statistics System provides reported and provisional drug overdose death estimates every month from January 2015 through the present (Ahmad et al., 2023). Estimates represent the count of deaths that occurred over the last 12 months since the month of the estimate. Data is available at the national and state levels for several drug classes. Stimulant use drug classes available in this data include cocaine (T40.5) and psychostimulants with abuse potential (T43.6), which includes methamphetamines. Figures 1 and 2 show trends in drug overdose deaths connected to stimulant use in the US and

Ohio between 2015 and 2023 where data is available. The reported number of deaths from cocaine and psychostimulants with abuse potential has increased dramatically between January 2015 and March 2023 in the U.S. Cocaine-related deaths rose from 5,496 to 28,783, while deaths attributed to psychostimulants with abuse potential surged from 4,402 to 35,462 during this period. Ohio has also witnessed a significant increase in overdose deaths due to these substances. From April 2015 to March 2023, cocaine overdose deaths in Ohio increased from 581 to 1,763, and overdose deaths related to psychostimulants with abuse potential rose from 77 to 1,401 (Ahmad et al., 2023).

According to the 2021 National Survey on Drug Use and Health (NSDUH), 1.6 million people over the age of 12 had methamphetamine use disorder, 1.4 million people had cocaine use disorder, and 1.5 million people had prescription stimulant use disorder in the U.S. (Substance Abuse and Mental Health Services Administration [SAMHSA], 2022). Reports of the percentage of the population using cocaine and methamphetamines show variation from year to year. The latest data from the NSDUH show that the prevalence of methamphetamine use in Ohio had a sharper increase (83%) than the United States (9%) from the period of 2017-2018 to 2018-2019. The prevalence of cocaine use in Ohio showed an increase of 8% for the same period, whereas there was a 5% decrease in the United States during that timeframe.

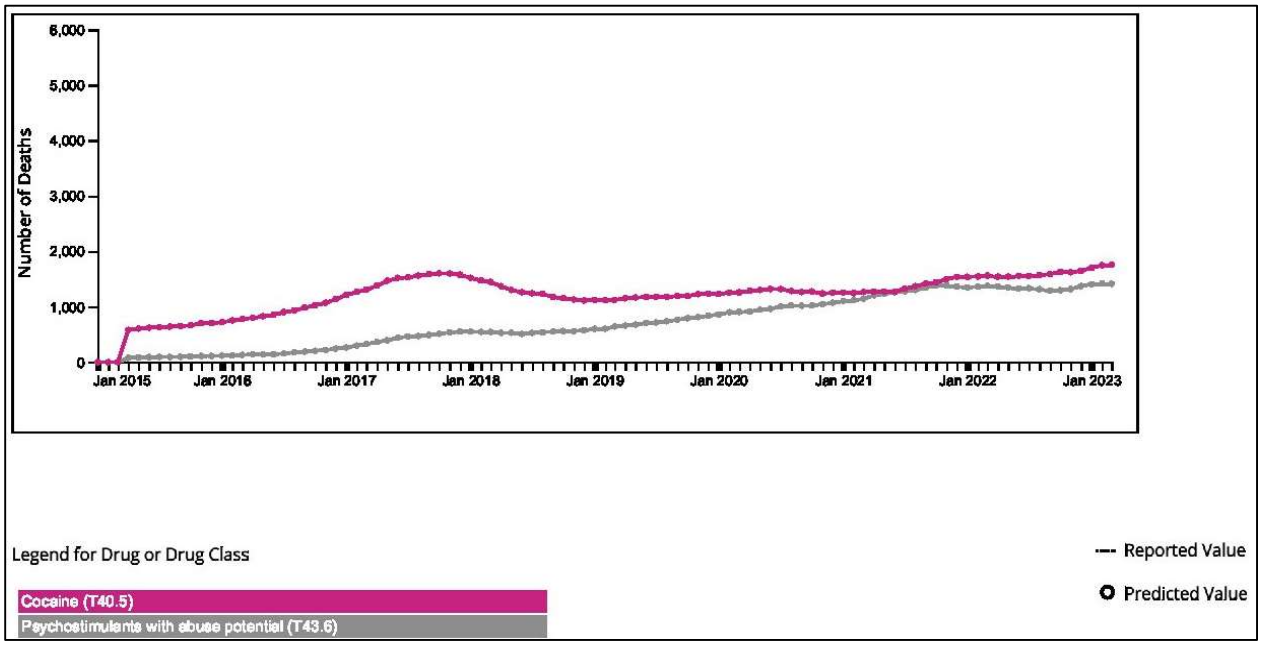
Figure 1

Provisional Number of Drug Overdose Deaths by Stimulant Drug or Drug Class, 2015-2023: United States

Source: Ahmad, F. B., Cisewski, J. A., Rossen, L. M., and Sutton, P. (2023). *Provisional drug overdose death counts.* National Center for Health Statistics.

Figure 2

Provisional Number of Drug Overdose Deaths by Stimulant Drug or Drug Class, 2015-2023: Ohio



Source: Ahmad, F. B., Cisewski, J. A., Rossen, L. M., and Sutton, P. (2023). *Provisional drug overdose death counts.* National Center for Health Statistics.

This report describes one clinical intervention designed to address stimulant misuse and prevent overdose deaths: the Matrix Model. The following sections outline a brief history of the treatment model as well as a summary of the results of a literature review conducted to understand the state of the research on the Matrix Model since its inception in the 1980s. The literature review aimed to answer the following questions regarding the impact of Matrix Model treatment on stimulant use and related outcomes:

1. What outcomes have been studied in the Matrix Model literature?
2. What is the impact of the original Matrix Model alone on stimulant use outcomes (referred to as "Matrix Model only")?
3. What is the impact of supplemented versions of the Matrix Model (referred to as "Matrix Model plus")?
4. What is the impact of the Matrix Model compared to other treatment strategies and conditions, including "treatment as usual" (TAU)?

Results from the literature review are organized and presented by outcome type: retention and treatment outcomes; functioning outcomes; craving outcomes; and other outcomes. For each outcome type, results are presented in order of scientific rigor, with findings from studies with the most scientifically rigorous designs (ex: Matrix Model vs. another treatment type) presented first.

A Response to Stimulant Use: The Matrix Model of Treatment

The Matrix Model (formerly known as the "neurobehavioral model") is a structured psychosocial protocol and treatment framework that was developed by Richard A. Rawson and his colleagues at the Matrix Institute in Southern California. The model was established in the

1980s in response to rapidly growing demand for drug abuse treatment services during the cocaine epidemic (Rawson et al., 1995). As a treatment framework, the Matrix Model was intended to help patients "(a) cease drug use, (b) remain in a treatment process for 12 months, (c) learn about issues critical to addiction and relapse, (d) receive direction and support from a trained therapist, (e) receive education for family members affected by the addiction, (f) become familiar with self-help programs, and (g) receive monitoring by urine testing" (Rawson et al, 1995, p. 119). Since its inception, the model has been evaluated and modified based on the experiences of individuals with cocaine use disorder (Rawson et al., 1995).

In 2018, Matrix Institute merged with CLARE Foundation, which was providing residential services for the treatment of substance use disorders. The combined entity is now known as CLARE|MATRIX, and offers outpatient, residential, and detox services, as well as training on the Matrix Model both nationally and internationally (CLARE|MATRIX, 2023).

Matrix Treatment Structure

In 1998, the SAMHSA Center for Substance Abuse Treatment (CSAT) funded the Methamphetamine Project, which was a large randomized controlled trial to implement and evaluate the Matrix Model. One condition of the funding was to give the rights of the Matrix Model to CSAT and make information about the model publicly available (D. Johnson, personal communication, September 25, 2023). CSAT published the Matrix Model manuals in 2006, and while other versions of the model have been developed over time, no further updates have been made publicly available. The following description of the Matrix Model treatment structure is based on the publicly available CSAT manual from 2006 (CSAT, 2006).

The intensive part of the CSAT Matrix Model treatment spans 16 weeks and includes individual, group, and family sessions with individual sessions being the primary component. The clients also start attending social support groups later in the treatment and continue to attend after intensive treatment ends. The content and focus of the group sessions evolve over time as the clients advance through the treatment process. The model also requires weekly drug and alcohol urinalysis.

Treatment includes three individual/conjoint sessions, eight early recovery skills group sessions, 32 relapse prevention group sessions, 12 family education sessions, and 36 social support sessions. Clients are also encouraged to attend 12-step programs or other support groups. Figure 3 shows a sample Matrix Model treatment schedule.

Figure 3

Sample Matrix Treatment Model Schedule

Schedule	Intensive Treatment Weeks 1 through 4*	Intensive Treatment Weeks 5 through 16†	Continuing Care Weeks 13 through 48
Monday	6:00–6:50 p.m. Early Recovery Skills 7:15–8:45 p.m. Relapse Prevention	7:00–8:30 p.m. Relapse Prevention	Nothing scheduled
Tuesday	12-Step/mutual-help group meetings	12-Step/mutual-help group meetings	12-Step/mutual-help group meetings
Wednesday	7:00–8:30 p.m. Family Education	7:00–8:30 p.m. Family Education or 7:00–8:30 p.m. Social Support	7:00–8:30 p.m. Social Support
Thursday	12-Step/mutual-help group meetings	12-Step/mutual-help group meetings	12-Step/mutual-help group meetings
Friday	6:00–6:50 p.m. Early Recovery Skills 7:15–8:45 p.m. Relapse Prevention	7:00–8:30 p.m. Relapse Prevention	Nothing scheduled
Saturday and Sunday	12-Step/mutual-help group meetings	12-Step/mutual-help group meetings	12-Step/mutual-help group meetings

* 1 Individual/Conjoint session at week 1

† 2 Individual/Conjoint sessions at week 5 or 6 and at week 16

Source: Center for Substance Abuse Treatment (2006). *Counselor's Treatment Manual: Matrix Intensive Outpatient Treatment for People with Stimulant Use Disorders.* HHS Publication No. (SMA) 13-4152. Rockville, MD: Substance Abuse and Mental Health Services Administration.

The continuing care phase of the model lasts 36 weeks and includes participation in social support and 12-step meetings. Intensive treatment and continuing care overlap for one month to allow for a smooth transition.

Individual/conjoint sessions are held three times throughout the treatment and may or may not include a family member. In these sessions, a counselor facilitates client engagement, monitors treatment progress, and provides support for recovery. Early recovery skills (ERS) groups are led by a counselor and client co-leader, who completed at least the first 8 weeks of the

program and remained abstinent from illicit drugs and alcohol over that period. ERS groups teach clients that they can learn new behaviors that will help them stay abstinent. Clients are also informed about the importance of attending 12-step or other help groups in conjunction with formal Matrix Model treatment. The 12-step meeting requirement can be met by any program that is accessible to the client and aligns with the client's needs. Relapse prevention (RP) groups are led by a counselor and a client co-leader who has completed the full year of treatment and successfully remained abstinent throughout that time. RP groups help clients stay abstinent by educating them on warning signs of relapse, redirecting clients who are about to relapse, and encouraging clients when they continue to stay abstinent. Each session focuses on a specific topic like emotional triggers and offers opportunities for group discussion. Family education groups provide information on addiction and recovery to clients and their families. The Matrix Model emphasizes that families and significant others are an important part of the recovery process if the client has close relationships with their significant others or families (CSAT, 2006). Finally, social support groups help clients "learn or relearn socialization skills" and focus on topics like intimacy, rejection, or work (CSAT, 2006, p.6).

Literature Review Process

Literature reviews are often conducted to understand a topic in depth. The stages of a literature review involve creating a search strategy, identifying relevant sources, summarizing and organizing them around relevant themes, and synthesizing the information that is presented by the sources. The purpose of this literature review was to assess the effectiveness and utility of the Matrix Model by identifying and synthesizing relevant studies examining the outcomes of the Matrix Model. This literature review also aimed to understand the types of outcomes studied in the Matrix Model research base.

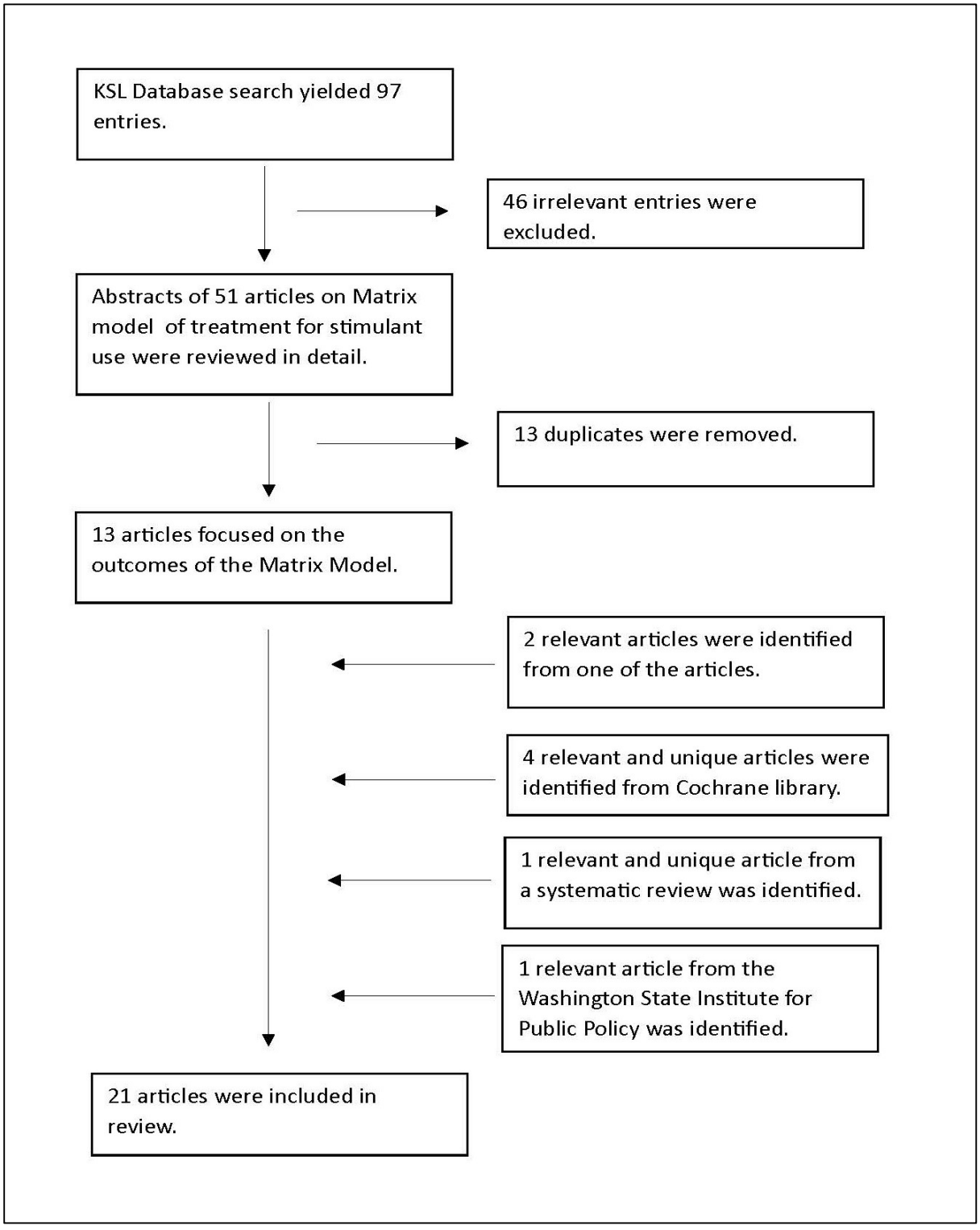
The first phase of the literature review included developing and refining relevant search phrases that represent the topic of interest and identifying key social and behavioral sciences research databases for use in the literature search. PsycINFO, MEDLINE, SocINDEX, Psychology and Behavioral Sciences Collection databases were searched using "(Matrix Model AND (cocaine OR methamphetamine OR amphetamine OR stimulant*)" phrases. The search was carried out in July 2023 and encompassed all existing literature up to that date. This search yielded a total of 97 results, which were subsequently screened for relevance. Fifty-one articles were found to be related to the Matrix Model and were selected for an initial review, which included scanning the abstracts of the articles. At this stage, 13 duplicate articles were removed, leaving 38 unique articles. Because the focus of this literature review is on treatment outcomes associated with the Matrix Model, studies were excluded if they did not include an investigation of treatment outcomes. The scientific rigor of the included studies was assessed based on their use of one of three types of research designs: (1) *experimental*, where participants are randomly assigned to one of multiple treatment conditions/groups that are compared to identify statistically significant differences; (2) *quasi-experimental*, which involves at least two treatment groups/conditions, but does not include random assignment; and (3) *nonexperimental*, which lacks random assignment of participants to study conditions and often evaluates a single treatment group. Experimental research designs were considered the most rigorous because they feature both random assignment and comparison groups. Among the screened articles, 13 reported findings from investigations that focused specifically on the outcomes of the Matrix Model. Full texts of these articles were retrieved for an in-depth review. Two additional articles were identified from the reference list of one of the reviewed articles.

The second phase included using the same search terms to conduct a similar search with the Cochrane Library, which is a well-reputed healthcare and medical research database that includes clinical trials, systematic reviews, and meta-analyses (Cochrane, 2023). This search yielded four unique and relevant articles which were included for an in-depth review. Two additional articles were identified through sources outside of the initial database searches. One was found on the Washington State Institute for Public Policy website, and the other was sourced from a systematic review.

The review included a total of 21 articles (see Appendix A for a full summary of the articles). Among those, nine used an experimental research design, eight used a nonexperimental design, and four used a quasi-experimental design. Figure 4 illustrates the literature review process.

Figure 4

Literature Search Process Funnel for Identifying Matrix Model Outcome Studies



Summary of the Matrix Model Outcome Studies

Several types of research designs and outcomes were present in the studies included in the literature review.

- Types of research designs in the reviewed studies: experimental (n=9), quasi-experimental (n=4), non-experimental (n=8).
- Outcomes examined (studies may have examined more than one outcome): retention/attendance (n=9), treatment completion (n=5), abstinence/relapse (n=14), functioning (n=11), craving (n=7), risky behaviors (n=1), treatment process factors (n=1), program attributes (n=1), physiological outcomes (n=1), and cognitive performance (n=1).
- Drug use type represented in study samples: primarily methamphetamine users (n=11), primarily cocaine users (n=4), primarily methamphetamine and cocaine users (n=2), stimulant users (n=2), amphetamine users (n=1), and methamphetamine and opioid users (n=1).
- Geographic locations of studies: United States (n=10), Iran (n=9), Thailand (n=1), South Africa (n=1).

While the majority of reviewed studies enrolled participants with methamphetamine use disorder, some studies enrolled participants with polysubstance use (i.e., methamphetamine and opioids). The Matrix Model outcomes identified from the reviewed studies were grouped into the following categories: (1) retention/treatment completion, (2) drug use/abstinence/relapse, (3) functioning, (4) craving, and (5) other outcomes. Findings related to each of the outcome categories and study designs will be outlined in the following sections.

1. Retention/Treatment Completion Outcomes

Retention was generally defined as the average number of sessions clients attended. Three studies compared the Matrix Model to another form of treatment (i.e., Rawson et al., 1985; Rawson et al., 2004; Rosenblum et al., 1999), two studies compared a Matrix Model only condition to a condition where the Matrix Model was combined with another intervention (i.e., Marinelli-Casey et al., 2008; and Shoptaw et al., 1995), and four studies included Matrix Model only treatment for examining retention outcomes (Huber et al., 1997; Magidson et al., 2017; Rawson et al., 1992; Shoptaw et al., 1995).

1.1. Matrix Model vs Other Treatment on Retention/Treatment Completion Outcomes

Few studies examined retention related outcomes by comparing the Matrix Model to another form of treatment. In 2004, Rawson and colleagues conducted a large, multi-site, controlled trial of the Matrix Model involving 978 participants. The study included eight sites, including one drug court site, that implemented the Matrix Model alongside TAU. The duration of TAU varied across sites, spanning from four to 16 weeks for the intensive phase of treatment, with participants expected to attend a total of one to 13 hours of sessions each week. Chi-squared analyses revealed a significantly higher percentage of the Matrix Model participants completed their treatment (40.9%) compared to TAU participants (34.2%). The authors then ran a series of multivariate regression models to understand how Matrix Model treatment vs TAU related to retention and treatment completion, while controlling for variables such as demographics and the frequency and route of methamphetamine use. Results showed that, in general, participants in the Matrix Model treatment condition had 27% higher odds of completing treatment compared to participants in the TAU condition (Rawson et al 2004). However, this trend was not observed at the drug court site, where TAU participants had 2.17 times higher odds of treatment completion

than Matrix Model participants (Rawson et al., 2004). An earlier descriptive analysis with 83 cocaine users found no significant differences in treatment completion between participants receiving Matrix Model treatment and those in inpatient treatment. In other words, most inpatient and Matrix Model participants completed their treatment at a similar rate (Rawson et al., 1985).

A controlled trial by Rosenblum et al. (1999) compared a high intensity Matrix Model-based cognitive behavioral intervention (a total of 120 sessions) to a low intensity non-Matrix Model treatment program (weekly group sessions scheduled for 26 weeks and brief check-ins) among 198 methadone patients with cocaine dependence. The study examined how treatment type (high intensity vs low intensity) is associated with retention (number of sessions attended) and treatment completion rates. Participants in the low intensity treatment attended a mean of 11.9 sessions, whereas participants in the high intensity Matrix Model condition attended a mean of 54.1 sessions. There was no relationship between the treatment condition and treatment completion rates (Rosenblum et al., 1999).

1.2. Matrix Model Only vs Matrix Model Plus on Retention/Treatment Completion Outcomes

Using secondary data from the large, controlled trial of the Matrix Model that was conducted by Rawson and colleagues in 2004, one study compared a Matrix Model only condition to a Matrix Model plus drug court condition model of treatment with 287 participants (Marinelli-Casey et al., 2008). The study found that a significantly higher proportion of Matrix Model plus drug court participants stayed in treatment longer than 30 days after initial admission (79%), compared to the Matrix Model only group (57%). The mean number of weeks in treatment for the Matrix Model plus drug court group was 11.2 weeks, which was significantly higher than Matrix Model only group (M=8 weeks). Being enrolled in drug court was the most

significant predictor of treatment completion, controlling for baseline participant demographics and drug use factors (Marinelli-Casey, 2008). Another study compared the Matrix Model only condition to a Matrix Model plus desipramine (an antidepressant) condition and found no difference between the two groups regarding retention in treatment (Shoptaw et al., 1995). Low adherence to desipramine was cited as the reason for the lack of difference between the groups.

1.3. Matrix Model Only on Retention/Treatment Completion Outcomes

Several other studies examined retention within the context of the Matrix Model without comparing it to another form of treatment (i.e., Huber et al., 1997; Magidson et al., 2017; and Rawson et al., 1992). All of these studies compared retention rates on the basis of participant characteristics. In addition, Magidson et al. (2017) also examined the role of motivation in retention. Huber et al. (1997) conducted a study comparing the number of sessions attended by a sample of 724 participants based on whether they used methamphetamines or cocaine. They found that both groups stayed in treatment for the same duration, although cocaine users received a significantly higher mean number of individual sessions (M=16.3) than methamphetamine users (M=13.3) (Huber et al., 1997). However, the authors asserted that treatment duration survival curves for both groups were almost identical. In an evaluation study of the Matrix Model in South Africa with a sample of 1,863 participants, Magidson et al (2017) compared methamphetamine users to opioid users on session attendance. They also examined the role of motivation on retention outcomes by using the Stages of Change Readiness and Treatment Eagerness Scale (SOCRATES; Miller & Tonigan, 1996) along with its subscales. The SOCRATES measures readiness for change while the "taking steps" subscale measures the degree to which clients are taking concrete actions for change. In this study, methamphetamine use was associated with greater odds of attending a higher number of sessions. Additionally,

higher scores on the SOCRATES taking steps subscale were associated with increased odds of retention in treatment. For each additional point received on the SOCRATES taking steps subscale score, the odds of completing four, eight, and 16 treatment sessions increased by 6%, 8%, and 11%, respectively (Magidson et al., 2017).

Lastly, Rawson et al. (1992) compared higher socioeconomic status (SES) to a lower SES treatment location group that provided the Matrix Model of treatment to 486 cocaine users. They found that 48% of higher SES location participants versus 22% of lower SES location participants completed the 6-month phase of the treatment. The higher SES location group averaged over five months of treatment whereas the lower SES location group averaged over three months in treatment. Also, a higher percentage of the lower SES location group (20%) dropped out of treatment within the first 2 weeks compared to the higher SES location group (8%) (Rawson et al., 1992).

1.4. Summary of Findings: Retention/Treatment Completion Outcomes

Studies varied in their methodologies (e.g., comparison groups, add-on interventions) when examining retention outcomes. While one study found no difference in retention between the Matrix Model and a less intense form of treatment (Rosenblum et al., 1999), another study showed that the Matrix Model may enhance retention outcomes compared to TAU (Rawson et al. 2004). The study that compared the Matrix Model only condition to the Matrix Model plus drug court condition showed that enrollment in drug court predicted treatment completion (Marinelli-Casey et al., 2008), suggesting that retention outcomes could be improved by combining the Matrix Model with drug court models. Studies that examined retention in Matrix Model treatment showed that retention may vary by participant drug of choice, type of treatment setting, and SES; however, more studies are needed to examine the effects of treatment model outcomes

and other participant variables. In sum, Matrix Model studies of retention/treatment completion outcomes indicate that the Matrix Model is a promising treatment model that could enhance retention outcomes.

2. Drug Use Outcomes

Drug use outcome measures included reductions in drug use, abstinence, and relapse outcomes. Five studies compared the Matrix Model to another form of treatment (i.e., Rawson et al., 1985; Rawson et al., 1995; Rawson et al., 2004; Rawson et al., 2012; Rosenblum et al., 1999), five studies compared the Matrix Model only to Matrix Model plus another form of treatment (i.e., Aryan et al., 2020; Fayaz Feyzi et al., 2022; Marinelli-Casey et al., 2008; Salehi et al., 2015; Shoptaw et al., 1995), and four studies only included the Matrix Model (Huber et al., 1997; Magidson et al., 2017; Moeeni et al., 2016; Rawson et al., 1992) for examining drug use outcomes.

2.1. Matrix Model vs Other Treatment on Drug Use Outcomes

Several studies compared the Matrix Model to another form of treatment regarding drug use outcomes. In their pilot study, Rawson et al. (1985) found that eight months after the evaluation, significantly fewer participants in Matrix Model treatment returned to monthly or more frequent cocaine use compared to those who received inpatient treatment or no formal treatment. The authors cautioned that the difference could be due to inpatient participants having a seven-month window for relapse after the treatment ended, whereas Matrix Model participants only had a two-month window.

Rawson et al. (1995) conducted a controlled trial with 100 participants to compare the effects of a Matrix Model program to those of a community resources group in the domain of

abstinence as measured by urinalysis and self-report of cocaine use. The community resources group was informed about treatment options and 40% of them reported receiving treatment ranging from outpatient to inpatient. No significant differences in abstinence outcomes were found between the two groups, and there were significant reductions in self-reported cocaine use from baseline to 12-month follow-up in both groups. Post hoc analyses showed a strong positive relationship between the amount of treatment received and abstinence from cocaine use (as measured by the percent of negative urinalyses results) among Matrix Model participants at 12-month follow-up. No such effect was observed in the community resources group (Rawson et al., 1995).

In a large, controlled trial of the Matrix Model, Rawson et al. (2004) found that, compared to TAU, Matrix Model participants had 31% higher odds of providing urine drug samples that were negative for substances outside the treatment plan, and the Matrix Model condition was related to longer average periods of abstinence at two out of eight sites. However, abstinence rates did not differ among the two treatment conditions at discharge and 6-month follow-up (Rawson et al., 2004). Rosenblum et al. (1999) did not find significant differences in reductions in cocaine use between the Matrix Model and low intensity treatment samples at posttreatment; however, there was an interaction effect for baseline cocaine use severity and treatment condition. As such, among those with more cocaine use at baseline, Matrix Model recipients had fewer cocaine positive samples at follow-up compared to those who received less intense treatment (Rosenblum et al., 1999).

Using the same data from the large, controlled trial, Rawson et al. (2012) examined the predictors of abstinence at 12-month and 36-month follow-up timepoints. The outcomes of the Matrix Model and TAU were examined both independently and as a combined sample. In the

Matrix Model group, having three consecutive negative urine samples during treatment was associated with 2.94 times higher odds of abstinence at 12-month follow-up. Conversely, the odds for abstinence decreased by 5% for each year of increase in age, and by 58% for those living in an unstable condition. Participants who had three consecutive negative urine samples during treatment had increased odds of abstinence at 36-month follow-up compared to those who had fewer than three negative samples (OR=3.07). In the TAU group, having three consecutive negative urine samples during treatment was associated with 3.05 times higher odds of abstinence at 12-month. Increases in the number of alcohol or drug treatments between baseline and 12-month follow-up were associated with 1.92 times higher odds of abstinence at 12-month, and none of the variables predicted abstinence at the 36-month assessment. In the combined sample, having three consecutive negative urine samples and increases in the number of alcohol or drug treatments between baseline and 12-month follow-up were associated with higher odds of abstinence, whereas older age was associated with lower odds of abstinence at 12-month and 36-month follow-up. Additionally, abstinence at 36-months was 31% lower for females than males.

2.2. Matrix Model Only vs Matrix Model Plus on Drug Use Outcomes

A series of studies compared a Matrix Model only condition to a Matrix Model plus other intervention condition. Some studies examined the effectiveness of a version of the Matrix Model that was combined or supplemented with medication (Aryan et al., 2020; Salehi et al., 2015; Shoptaw et al., 1995). Shoptaw et al. (1995) compared the effectiveness of the Matrix Model plus desipramine to Matrix Model only and Matrix Model plus placebo conditions. The study did not show a significant effect of desipramine on abstinence (the adherence to medication was low), however participants had better abstinence outcomes if they stayed in

treatment longer and if they had higher rates of negative urine samples during treatment (Shoptaw et al., 1995).

In their study, Aryan et al. (2020) explored methylphenidate (MPH), a type of stimulant that is typically prescribed for the treatment of attention-deficit and hyperactivity disorder, as another potential supplement to the Matrix Model. The authors compared four treatment conditions that included Matrix Model plus MPH, Matrix Model only, MPH only, and a control condition that received no treatment. The Matrix Model plus MPH group had the greatest decline in the number of methamphetamine positive urine tests compared to other groups. Similarly, Salehi et al. (2015) compared Matrix Model plus buprenorphine medication to a Matrix Model plus placebo condition. The Matrix Model plus buprenorphine group consistently had lower rates of positive urine tests starting from the third week and until the 26th week. No significant differences were found at the last treatment visit, which was at week 28.

One study used a brain stimulation technique (i.e., transcranial direct current stimulation; tDCS) in conjunction with the Matrix Model and compared it to a Matrix Model only group and a Matrix Model plus placebo (sham tDCS) group. Relapse rates were lower in the Matrix Model plus active tDCS group, but the difference among the three groups was not significant (Fayaz Feyzi et al., 2022). More studies are needed to understand if brain stimulation techniques could be helpful for achieving abstinence when combined with Matrix Model.

Lastly, one study compared a Matrix Model plus drug court group to a Matrix Model only group and found that a higher percentage of Matrix Model plus drug court participants provided methamphetamine-free urine samples than those in the Matrix Model only group (Marinelli-Casey et al., 2008). Being enrolled in the drug court predicted higher odds of being abstinent during treatment. The Matrix Model plus drug court group had greater reductions in

methamphetamine-positive urine samples at discharge and at 6-month and 12-month follow-up assessments. This study found that a higher percentage of methamphetamine-free urinalysis drug screen samples in treatment predicted decreased methamphetamine use at follow up (Marinelli-Casey et al., 2008). A similar finding was reported in a 2012 study conducted by Rawson and colleagues (Rawson et al., 2012).

2.3. Matrix Model Only on Drug Use Outcomes

Few studies included only the Matrix Model and compared participant characteristics on drug use outcomes. Rawson et al. (1992) compared cocaine use outcomes for two locations characterized by higher SES vs. lower SES that provided Matrix Model treatment. Among those who completed 6-month treatment, 44% of high SES location group and 40% of low SES location group had negative urine drug screening samples (Rawson et al., 1992). Huber et al. (1997) compared methamphetamine and cocaine users on drug use and did not find a significant difference in testing positive for their choice of drug during treatment. Moeeni et al. (2016) examined the Matrix Model and the role of treatment attendance, history of casual sex habits, history of criminal offense, family support, the duration of amphetamine addiction on relapse, and other characteristics among those who were using amphetamines in Iran. Less treatment attendance, history of criminal offense, and longer duration of amphetamine dependence predicted relapse. A history of casual sex predicted shorter time to relapse whereas stronger family support predicted longer time to relapse (Moeeni et al., 2016).

Focusing on the role of primary drug of choice and motivation, Magidson et al. (2017) found that only the taking steps subscale of the SOCRATES predicted abstinence from drug use among a sample of participants whose primary choice of substance was methamphetamine or opioids (n= 645). For each point increase in the scale, the odds of being abstinent upon exiting

treatment increased by 12%. The primary drug of choice was not related to the abstinence outcomes.

2.4. Summary of Findings: Drug Use/Abstinence/Relapse Outcomes

In conclusion, two studies provided support for the Matrix Model in improving drug use outcomes compared to TAU (Rawson et al., 2004) and inpatient treatment (Rawson et al., 1985). According to one study, no differences were detected in longer term follow-up outcomes between Matrix Model and TAU (Rawson et al., 2004). Another study found that methamphetamine-dependent individuals in programs that helped them stay abstinent for a minimum of three consecutive weeks during treatment had more success with long-term abstinence (Rawson et al., 2012). Some studies showed that improvements in drug use-related outcomes may depend on drug use severity prior to treatment (Rosenblum et al., 1999) and in-treatment abstinence (Marinelli-Casey et al., 2008; Rawson et al., 2012). As such, Rosenblum et al. (1999) found that participants with severe drug use at baseline had fewer drug positive urine drug screening samples at follow up if they received Matrix Model treatment. Similarly, having drug-free urine results during treatment (for at least three consecutive weeks) predicted 12-month abstinence for both Matrix Model and TAU, although abstinence at 36-month follow up was reported only in the Matrix Model group (Rawson et al., 2012). While these studies demonstrate some evidence for the effectiveness of the Matrix Model in achieving abstinence, reducing drug use, or preventing relapse, they also suggest that these outcomes may depend on several factors other than the model itself.

Studies involving the Matrix Model plus another intervention examined a range of model enhancements, such as various medications, brain stimulation techniques, or drug court. Most of these studies showed promising results, especially for abstinence from drug use. Taken together,

these studies suggest that the benefits of the Matrix Model could be amplified by adding a psychopharmacological, medical (e.g., brain stimulation), or other (i.e., drug court model) intervention. More research is needed to understand what types of medications or interventions work best in conjunction with the Matrix Model.

Choice of drug used, treatment duration, family support, and client motivation levels all showed potential influence on the drug use outcomes of the Matrix Model. However, predictors and samples varied across the studies making it difficult to draw specific conclusions and generalize findings. More studies are needed in this area to understand which participant characteristics relate to abstinence and relapse outcomes.

In sum, similar to retention outcomes, the Matrix Model is a promising treatment approach for improving drug use outcomes for individuals diagnosed with stimulant use disorder. Some studies pointed to the importance of achieving a period of abstinence during treatment and longer treatment episodes in achieving subsequent abstinence or decreased drug use over time. Providing psychopharmacological, other medical or psychosocial interventions in conjunction with the Matrix Model has the potential for achieving desired drug use-related outcomes.

3. Functioning Outcomes

With regard to outcomes related to participant functioning, studies often focused on the severity of addiction (i.e., as measured by Addiction Severity Index; ASI[1]), as well as depressive and anxiety symptoms. Five studies compared the Matrix Model to another form of treatment (Basereh et al., 2022; Pergparn et al., 2011; Rawson et al., 1995; Rawson et al., 2004; Rosenblum et al., 1999), four studies compared Matrix Model only to Matrix Model plus another form of

[1] Addiction Severity Index (ASI; McLellan et al., 1992) includes information on the nature, number, and severity of seven life domains: drug, alcohol, employment, family/social, legal, medical, and psychiatric.

treatment (Aryan et al., 2020; Azadbakht et al., 2022; Marinelli-Casey et al., 2008; Shoptaw et al., 1995), and one study only included Matrix Model treatment (Masaeli et al., 2018) for examining functioning outcomes.

3.1. Matrix Model vs Other Treatment on Functioning Outcomes

Several studies compared the Matrix Model to another form of treatment in functioning outcomes. One study examined psychiatric outcomes, including mood disorders, anxiety disorders, positive affect, and antisocial personality disorder using assessment tools, such as the brief symptom inventory (BSI) and SCID (Rosenblum et al. 1999). In this study, the high intensity Matrix Model group saw larger decreases in BSI scores (signifying fewer psychiatric symptoms and better psychiatric functioning) than the low-intensity non-Matrix Model group. However, the authors note that the BSI for the high-intensity group was significantly higher than that of the low-intensity group at baseline and suggest that the lowered BSI scores in the high-intensity group could be more related to a regression to the mean effect rather than Matrix Model treatment. In contrast, a study by Rawson et al. (1995) that compared the Matrix Model to a community resource group intervention, did not find any differences between the two groups in depressive symptoms or in Addiction Severity Index (ASI) scores. However, the study showed that greater participation in treatment in the Matrix Model group was significantly related to improvements in employment and family domains of the ASI. No such effect was observed for the community resource group. Similarly, Rawson et al. (2004) did not find any difference in ASI domains among methamphetamine users assigned to Matrix Model and TAU conditions. Both groups showed improvements in the drug, alcohol, psychiatric, and family domains of the ASI across six months.

Pergparn et al (2011) compared the Matrix Model to an inpatient treatment and examined functioning outcomes among yaba (an illicit drug which is a combination of methamphetamine and caffeine) users in Thailand. They found that both groups showed significant improvements in self-esteem, depression and anxiety measures from 1.5 to 3 months. The Matrix Model group also had significant improvement in self-efficacy, however, no such improvement was observed among the inpatient group. Lastly, Basereh et al. (2022) compared a Matrix Model group, a dialectical behavioral therapy (DBT) group, and a control group (that received buprenorphine medication treatment only) on three measures assessing self-efficacy for quitting drug use, mindfulness (awareness of the present moment without judgment), and distress tolerance (the ability to tolerate negative emotions) among Iranian stimulant users. The Matrix Model group had significantly higher scores on the measures of self-efficacy, distress tolerance, and mindfulness compared to the control group. The DBT group scored significantly higher on the measure of distress tolerance compared to the Matrix Model group; however, the two groups did not significantly differ in self-efficacy or mindfulness ratings (Basereh et al., 2022).

3.2. Matrix Model Only vs Matrix Model Plus on Functioning Outcomes

Several studies compared functioning-related outcomes for the Matrix Model only to the Matrix Model plus another intervention. Some studies found that the Matrix Model plus another form of treatment was more effective than either the Matrix Model alone or another treatment condition. For example, Aryan et al. (2020) compared four treatment conditions that included the Matrix model plus the medication methylphenidate (MPH), Matrix Model only, MPH medication-only, and control condition that received no treatment. The four conditions were

assessed for their impact on mental health status as measured by General Health Questionnaire[2], and severity of dependency on substances as measured by Leeds Dependence Questionnaire[3]. Compared to the other conditions, the Matrix Model plus MPH condition was associated with significantly higher increases in positive mental health and reductions in severity of dependency.

Another study showed that both a Matrix Model plus drug court group and a Matrix Model only group had significant improvements in the legal, employment, medical, psychological, family and alcohol domains of the ASI (Marinelli-Casey et al. 2008). The only difference observed between the two groups was in the drug use domain (Marinelli-Casey et al. 2008). However, Matrix Model plus drug court participants had greater reductions in the drug use domain compared to Matrix Model only participants. In a similar study, Shoptaw et al (1995) also found significant improvements in the family, psychological, drug and alcohol domains of ASI for participants in the Matrix Model only or Matrix Model plus desipramine medication conditions. Improvements were also noted in prosocial behaviors as measured by the Behavioral Change Index[4] (BCI), as well as in depressive symptoms as measured by the Center for Epidemiological Studies-Depression[5] (CES-D) scale. There were no significant differences noted in these improvements between groups.

Lastly, one study looked at the effect of intranasally administrated oxytocin on anxiety and depressive symptoms among participants receiving Matrix Model treatment (Azadbakht et al., 2022). Compared to the Matrix Model plus placebo group, after four weeks of treatment, the

[2] General Health Questionnaire (GHQ-12; Goldberg et al., 1988) measures psychological distress.
[3] Leeds Dependence Questionnaire (LDQ-10; Raistrick et al., 1994) measures dependency on various substances.
[4] Behavioral Change Index[4] (BCI; Rawson, 1985) measures drug/alcohol and prosocial behaviors.
[5] The Center for Epidemiological Studies-Depression (CES-D; Radloff, 1977) measures depressive symptoms.

Matrix Model plus oxytocin group had significant improvements in depressive symptoms as measured by the Beck Depression Inventory[6]. No differences were found in anxiety symptoms.

3.3. Matrix Model Only on Functioning Outcomes

A 2018 study by Masaeli and colleagues included Matrix Model participants and their caregivers and examined their quality of life, depressive symptoms, and anxiety symptoms at multiple timepoints (at baseline, two months after sessions, and six months after sessions). Both caregivers and Matrix Model participants showed significant improvements between baseline and follow-up timepoints on all outcome measures.

3.4. Summary of Findings: Functioning Outcomes

Several studies measured different types of functioning outcomes, including addiction severity, depressive symptoms, and anxiety symptoms. Of the studies noted, most provided support for the effectiveness of the Matrix Model in increasing quality of life, decreasing depressive and anxiety symptoms, and increasing functioning in the legal, employment, medical, psychological, family and alcohol domains of the ASI. According to a few comparative studies (Rawson et al., 1995 and Rawson et al., 2004), the Matrix Model did not show superior performance over other forms of treatment in improving functioning outcomes. A few studies demonstrated that augmenting the Matrix Model with another form of treatment (e.g., MPH or oxytocin) may enhance functioning outcomes, such as mental health symptoms (e.g., Aryan et al., 2020 and Azadbakht et al. 2022).

[6] Beck Depression Inventory measures depressive symptoms.

4. Craving Outcomes

Studies that focused on craving outcomes used measurement tools such as the Cocaine Craving Questionnaire Brief (CCQ) or The Desire for Drug Questionnaire (DDQ), both of which include questions related to the desire to use methamphetamines or cocaine. Seven studies included a measure of craving (i.e., Aryan et al. 2020; Azadbakht et al., 2022; Esmaeli et al. 2021; Fayaz Feyzi et al., 2022; Mousavi et al., 2015; Salehi et al., 2015; and Shoptaw et al., 1995).

4.1. Matrix Model vs Other Treatment

Only one study compared the Matrix Model to another form of treatment (i.e., Esmaeli et al., 2021). Esmaeli et al. (2021) compared the Matrix Model to cognitive rehabilitation (i.e., dot-probe training[7]), brain stimulation-- repetitive transcranial magnetic stimulation (rTMS), and a control group. Both intervention groups had significant decreases in craving as measured by the DDQ and by attentional bias towards craving-related cues, as measured by the dot-probe training task. There were no significant differences between the intervention groups.

4.2. Matrix Model vs Matrix Model Plus

Six studies investigated the effectiveness of augmenting the Matrix Model with medications to treat stimulant use disorder, with the goal of mitigating craving to prevent relapse and reducing the severity of addiction. Medications varied across studies and included methylphenidate (MPH), oxytocin, buprenorphine, N-acetylcysteine (NAC) and desipramine. One study included a brain stimulation technique (transcranial direct current stimulation; tDCS).

[7] Dot-probe training: A form of cognitive rehabilitation training that is used to modify attentional biases by repeatedly exposing participants to neutral and craving related stimuli (e.g., pictures). The goal is to shift attention away from the craving related stimuli.

Salehi et al. (2015) compared a Matrix Model plus buprenorphine group to a Matrix Model plus placebo group and found that the buprenorphine group consistently had lower mean scores on craving starting from Week 8 (third visit) that lasted through Week 28 (11th visit) of treatment. Mousavi et al. (2015) examined the effectiveness of NAC on craving among participants with methamphetamine dependence. In this crossover study, half of the participants received the Matrix Model plus NAC and the other half received the Matrix Model plus a placebo in the first four weeks of study. In the next four weeks, each group received crossover intervention. The authors found reduced craving scores when participants were taking NAC, whereas this effect was not observed for placebo conditions. Aryan et al. (2020) used the DDQ to measure craving in four treatment conditions: Matrix Model plus MPH, Matrix Model only, MPH only, and a control condition that received no treatment. They found that the Matrix Model plus MPH group had significant reductions in craving scores. A study by Azadbakht and colleagues examined the additional effect of oxytocin on craving using a version of the CCQ that was adapted for methamphetamine users. Participants were assigned to either a Matrix Model plus placebo group or a Matrix Model plus oxytocin group (Azadbakht et al., 2022). After four weeks of treatment, the Matrix Model plus oxytocin group had significantly improved CCQ craving scores. In contrast, Shoptaw et al. (1995) did not find significant differences in craving between those who received the Matrix Model only, the Matrix Model plus desipramine medicine, or the Matrix Model plus placebo. However, there was a significant reduction in craving at 6-month assessment in the combined sample.

One study examined the effectiveness of a brain stimulation technique called tDCS over dorsolateral prefrontal cortex on craving. The study had three groups, including Matrix Model plus active tDCS, Matrix Model plus sham tDCS, and Matrix Model only (Fayaz Feyzi et al.,

2022). Drug craving in all three groups declined from baseline to follow-up, but the change was only significant for the Matrix Model plus active tDCS group. The Matrix Model plus active tDCS group had the greatest reduction with a large effect size.

4.3. Summary of Findings: Craving Outcomes

Studies show strong support for add-on pharmacological interventions in reducing craving. However, it is difficult to draw a conclusion about which medication should be used in conjunction with the Matrix Model because the types of medication used varied across studies.

5. Other Outcomes

Some studies focused on miscellaneous outcomes. These outcomes include treatment process and program attributes (Pergparn et al., 2011), risky behaviors (Rawson et al., 2008), physiological outcomes (Azadbakht et al., 2022), and cognitive performance (Esmaeli et al., 2021, and Fayaz Feyzi et al., 2022).

5.1. Ratings for Treatment Process and Program Attributes

Pergparn et al (2011) explored how yaba[8] users in Thailand rated treatment process and program attribute outcomes for the Matrix Model compared to an inpatient treatment program. Within-group comparisons showed that the ratings for the inpatient program improved for measures of treatment process (e.g., participation in treatment) and program attributes (e.g., peer support, counselor attitudes) from 1.5 to 3 months into treatment. No significant changes were detected for the Matrix Model ratings over that timeframe.

5.2. Risky Behaviors

[8] Yaba: An illicit drug which is a combination of methamphetamine and caffeine.

Rawson et al. (2008) used secondary data to examine risky behaviors, including high-risk sexual behaviors and injection practices among methamphetamine users receiving Matrix Model treatment or TAU. No significant differences were found between the Matrix Model and TAU groups. However, the combined sample had reductions in risky sexual behaviors and injection behaviors from baseline to treatment discharge. Those who stayed in treatment longer had larger reductions in risky sexual and injection behaviors.

5.3. Physiological Outcomes

Azadbakht et al. (2022) examined the effect of oxytocin on two stress hormones - adrenocorticotropic hormone (ACTH) and cortisol for a Matrix Model plus placebo group and a Matrix Model plus oxytocin group. The Matrix Model plus oxytocin group had significant decreases in cortisol levels at the end of the trial and four weeks after the treatment, as well as decreased ACTH at the end of treatment.

5.4. Cognitive Performance Outcomes

One study employed measures of cognitive performance tests to evaluate the effectiveness of tDCS on cognitive performance measures such as visual and auditory memory (Fayaz Feyzi et al., 2022). The study had three groups: Matrix Model plus active tDCS, Matrix Model plus sham tDCS, and Matrix Model only. Based on Wechsler Memory Scale (WMS) scores, the Matrix Model plus active tDCS group showed significantly better performance in auditory and visual memory at post-intervention compared to the baseline. The sham tDCS group showed an improvement in visual working memory, but poorer auditory working memory in the post-intervention score compared to the baseline, both of which were non-significant. There was a non-significant improvement in both subscales of the WMS from baseline to post-intervention

in the Matrix Model only group. The Matrix Model plus active tDCS group showed a significant increase in the number of true answers and a significant decrease in the number of false answers from baseline to post-intervention on the Wisconsin Card Sorting Test (WCST). The other two groups also showed improvements in a similar direction, but they were not significant. ANCOVA analyses showed no significant differences in audio and visual memory or WCST between the groups. In sum, significant gains in cognitive performance, as measured by the WCST, were only made in the Matrix Model plus active tDCS group.

5.5. Summary of Findings: Other Outcomes

Two studies provide support for the superiority of the Matrix Model plus another intervention (oxytocin on stress hormones and tDCS on cognitive performance) over the Matrix Model only or Matrix Model plus a placebo. No differences were observed for risky behaviors between Matrix Model and TAU groups in one study, however, receiving treatment appeared related to reductions in risky sexual and injection behaviors, especially when the participants stayed in treatment longer, or when they completed treatment. While one study of treatment process variables did not detect significant change for the Matrix Model group, the findings do not suggest that the Matrix Model group had poor treatment process outcomes. In conclusion, these study outcomes provide some support for the effectiveness of the Matrix Model on a diverse set of outcomes.

Limitations

A major limitation of the literature to date is the lack of research on more recent versions and iterations of the Matrix Model, including the current CLARE|MATRIX Model. The Matrix Model evolved over time to incorporate cognitive behavioral therapy, contingency management,

and motivational interviewing (CLARE|MATRIX, 2023). In September 2023, investigators conducted a benchmarking interview with the CLARE|MATRIX training director to obtain the most recent and updated research information about the Matrix Model. The interview revealed that CLARE|MATRIX does not use the 2006 CSAT version of the Matrix Model, which is considered outdated. Instead, they use and provide training on the newer, revised version of the Matrix Model that integrates motivational interviewing, cognitive-behavioral techniques, and contingency management, as well as retaining twelve-step facilitation (TSF) and family involvement (D. Johnson, personal communication, September 25, 2023; CLARE|MATRIX, 2023). Another notable finding was that no research has been published on the revised or population-specific models that CLARE|MATRIX uses. CLARE|MATRIX is the sole source of training on the updated models and offers provider trainings as well as organizational certification programs (D. Johnson, personal communication, September 25, 2023). Currently, CLARE|MATRIX offers three versions of the Matrix Model manual and curriculum- one for adults, one for youth, and one for criminal justice settings (CLARE|MATRIX, 2023). Manuals for the updated Matrix Models, such as the new *Matrix Model Intensive Outpatient Alcohol and Drug Treatment Program* therapist's manual, were published in 2014 and are only available for purchase through Hazelden Publishing. This report describes the Matrix Model based on the manual that was published by CSAT since there is no publicly available information on any of the revised models. The extent to which the structures of new models differ from the older model remains unclear. Furthermore, despite using multiple search engines and research databases, all the studies that were retrieved for the literature search were conducted on the 2006 version of the Matrix Model that was made publicly available by CSAT. While all reported findings correspond

directly to the version of the model described, there is a gap in the research regarding the effectiveness of the most recent versions of the Matrix Model.

Analysis of the Matrix Model in Formal Registries

The two EBP registries that provided a rating for the Matrix Model were the Washington State Institute for Public Policy (WSIPP) and the California Evidence-Based Clearinghouse for Child Welfare (CEBC). Each registry has slightly different criteria for EBP rating. WSIPP has a three level-rating system for EBPs: promising, research-based, evidence-based (Miller et al., 2016). For a treatment model to be considered "evidence-based," it needs to undergo a rigorous research process, including a large randomized clinical trial, multiple controlled trials, or statistically controlled evaluations. The model should demonstrate sustained improvement in at least one outcome and be considered cost-beneficial. A rating of "research-based" is applied to a treatment model if it has a single controlled trial or a statistically controlled evaluation, shows sustained improvement, but does not meet cost-effectiveness criteria. Lastly, a "promising" practice rating refers to a treatment model with the potential for meeting EBP standards that is also supported by statistical analyses or theory of change. The Matrix Model for stimulant use was rated as a research-based treatment by the WSIPP. It was not classified as an evidence-based practice because it did not meet the threshold for cost-effectiveness.

The CEBC uses a scientific rating scale with scores ranging from one to five (1= well-supported practice and 5= concerning practice). Each rating includes detailed criteria. For example, to attain a "well-supported" rating, a treatment model needs to have at least two rigorous randomized controlled trials. Among these trials, at least one should demonstrate a sustained effect lasting for a minimum of one year after treatment completion. These studies should also incorporate reliable and valid measurement tools, ensure the treatment has no risk to

participants, and provide a treatment manual. The Matrix Model received a rating of 3-Promising Research Evidence because it has been investigated by at least one study that had a comparison group and the treatment showed superior outcomes compared to the comparison group. According to the CEBC website, the Matrix Model was last reviewed in 2023. However, the reference list does not appear to have been updated to include the most recent international studies that were conducted in Iran.

Even though two EBP registries provided ratings for the Matrix Model, a comprehensive and current literature review was deemed necessary to further understand the domains impacted by the Matrix Model. Our analysis of the literature shows that the Matrix Model is associated with promising and mixed outcomes, particularly in terms of retention, reduced drug use, and improved functioning. For example, a large randomized clinical trial in the U.S. showed that a higher percentage of the Matrix Model participants stayed in treatment and had higher odds of treatment completion compared to most TAU participants (Rawson et al., 2004); however, another trial did not find a difference in treatment completion between the Matrix Model group and a comparison group (Rosenblum et al., 1999). Two U.S.-based studies suggested that Matrix Model treatments were associated with improved drug use-related outcomes; however, in long-term follow-up comparisons, no differences were detected between the groups (Rawson et al., 1985; Rawson et al., 2004). Two studies from Iran found promising results for the Matrix Model compared to two control group conditions (either received no treatment or received medication only), but not necessarily compared to other forms of treatment (Basereh et al., 2022; Esmaeli et al., 2021). Other studies reported that drug use outcomes may depend on factors such as in-treatment abstinence and baseline drug use severity, treatment attendance, duration of

dependence, criminal history, and family support (Rawson et al., 2012; Rosenblum et al., 1999; Moeeni et al., 2016).

Matrix Model Research Summary

The Matrix Model has a long history of use in the treatment of stimulant use disorders. What sets it apart from other treatments is that it is a structured, manualized treatment that is specifically developed for individuals with stimulant use disorders. Like many other treatment models, it continuously evolved to better respond to the needs of individuals with addictions. The most recent version includes components from motivational interviewing and contingency management.

It is important to note that the most recent studies regarding the Matrix Model were conducted in Iran (9 out of 21 studies). Caution must be exercised in generalizing these findings to the U.S. due to the significant contextual and cultural differences that may impact treatment delivery and outcomes across countries. For example, it is important to note that the studies conducted in Iran enrolled samples that were almost entirely male. Only one of the Iranian studies appeared to implement most components of the Matrix Model, whereas most studies in the U.S. were conducted within Matrix clinics, with three of those studies using secondary data from research conducted in these clinical settings. Several of the Iranian studies examined the effectiveness of medication combined with the Matrix Model and one study augmented the Matrix Model with a brain stimulation technique. These studies showed superior outcomes compared to Matrix Model only or a control group condition. However, some findings were only evident under certain conditions. For example, improved outcomes at the time of discharge from treatment but not at follow-up (i.e., Azadbakht et al., 2022), or for only a portion of the duration of treatment (i.e., Salehi et al., 2015). Only one study in the U.S. examined the effectiveness of

medication combined with the Matrix Model, but medication did not appear to significantly impact treatment outcomes, perhaps due to poor medication adherence (Shoptaw et al., 1995).

Several studies compared the Matrix Model alone to the Matrix Model plus another intervention. It is not unusual to supplement or augment evidence-based interventions with other models or practices to strengthen the overall treatment effect through the new combined intervention as new research emerges about EBPs. These augmentation strategies are common in various types of treatment research but can present challenges to researchers when trying to disentangle the unique effects of specific treatment components. This was true in our review of augmented Matrix Model research employing various pharmacologic, brain stimulation, and drug court supplements.

Conclusion

Overall, some support exists for the utility of the Matrix Model for individuals with stimulant use disorders. More research is needed, particularly given that the Matrix Model has been expanded to incorporate additional treatment elements like contingency management and motivational interviewing. Additionally, it is important that future studies include a measure of fidelity to assist with the interpretation of the findings. For example, although some other studies discussed treatment manuals or provided a table outlining the treatment sessions, only one study explicitly examined fidelity (i.e., Rawson et al., 2004). The lack of fidelity-related variables made it difficult to understand how faithfully the model was being implemented in different studies.

One advantage of the Matrix Model is its structured treatment manual, which can facilitate successful implementation. The highly structured treatment framework could be

especially beneficial for implementing complex and multicomponent treatment regimes. However, the model's use of multiple treatment modalities and a combination of individual, group, and family sessions could be resource-intensive and thus difficult for some organizations to adopt. One EBP rating system noted that the Matrix Model did not meet criteria for cost-effectiveness, which could be a major barrier to adoption and implementation. Findings suggested that the Matrix Model is more effective when combined with another type of intervention, such as pharmacotherapy, brain stimulation, or drug court. This could be encouraging for organizations and programs that can or do offer a complementary intervention type (i.e., pharmacotherapy, brain stimulation), but could otherwise present another barrier to adoption or implementation. Perhaps because it was designed with stimulant users in mind, the Matrix Model seems to integrate an understanding of the complexities of a recovery process. The Matrix Model attempts to address the unique needs that arise at each step of the recovery process by using a comprehensive psychosocial treatment structure that is compatible with other types of interventions that may be deemed necessary for the client, such as drug court.

One limitation of the literature to date is that all available research was conducted on the old version of the Matrix Model, which means that the effectiveness of the most recent versions of the Matrix Model is unclear. Despite the limitations, findings from this literature review suggest that the original Matrix Model has promise as an approach for assisting clients in their recovery journey. Additional research, especially with the most recent versions of the Matrix Model, could provide more detailed insight into the utility of the model as well as broaden our understanding of how the model can be applied to diverse populations and settings.

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