Navigating the Crossroads Between Early Motherhood and Mental Health: Exploring the Role of eHealth in Addressing Mental Health and At-Risk Substance Use Among a Stigmatized and Understudied Population

by

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ABSTRACT

Individuals with co-occurring mental health concerns and at-risk substance use (ARSU+) face barriers to accessing effective treatments. eHealth treatments may offer an alternative to address unmet needs, particularly for underserved populations such as mothers of young children. However, most treatments address mental health or substance use in isolation, which may limit accessibility and relevance for those with ARSU+. Alcohol and cannabis use were the focus of this dissertation due to their high prevalence, legal status, and frequent mental health comorbidity. This dissertation aimed to evaluate the feasibility, clinical utility, and effectiveness of eHealth treatments in general populations and/or mothers of young children. In Study 1, I conducted a meta-analysis and systematic review of 93 randomized controlled trials (RCTs; N = 51,833) to assess eHealth treatment effectiveness. Small effects were shown for alcohol use at post-treatment and cannabis use at follow-up. Moderator analyses revealed larger effects in studies with older samples, non-college/university samples, and those that targeted individuals with at-risk substance use. Treatment components associated with greater alcohol use reductions included relapse prevention, motivational interviewing, cognitive strategies, and emotion regulation and mental health support. In Study 2, I conducted a secondary data analysis of two RCTs evaluating the Building Emotional Awareness and Mental health program, a mental health and parenting treatment for mothers with young children. Feasibility and symptom trajectories were compared among those with ARSU+ (n = 33) and those with mental health concerns without at-risk substance use (ARSU-; n = 77). Significant reductions in depression, anxiety, anger, sleep disturbances, and parenting stress were observed over time in mothers with ARSU+. These improvements were comparable to those observed in the ARSU- group, even after adjusting for enrollment symptom severity. Together, findings suggest eHealth treatments are

associated with reductions in alcohol and cannabis use in the general population and may be feasible and support symptom improvements in mothers with ARSU+. Results underscore that single-focus eHealth treatments targeting mental health or substance use alone may still offer preliminary benefit for individuals with ARSU+. These findings highlight the potential value of flexible and inclusive approaches to treatment development and implementation.

Keywords: Anxiety, At-risk substance use, Co-morbidity, Depression, Digital health, eHealth, Meta-analysis, Mothers

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DEDICATION

To my younger self,

Thank you for surviving what you were not able to name at the time. The struggles you faced laid the foundation for the work I do every day and led me to a field I love – Clinical Psychology. It was through your pain and resilience that I came to understand the urgency and impact of mental health.

Your strength helped us overcome so much. Instead of letting doors close in your face, you continued opening them – doors to healing, to understanding, and ultimately, to the chair I will sit in as a Clinical Psychologist. This academic endeavor would not have been possible without your stubbornness, hope, and unwavering willingness to move forward.

You did not know it then, but you were helping me build a life worth living. This dissertation, in many ways, is our story – and a promise to every person who is trying to conquer their own "invisible" mountain.

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CONTRIBUTIONS

Kayla Joyce authored this dissertation. All sections were revised based on feedback from her supervisor, Dr. Leslie Roos, and committee members, Drs. Kristin Reynolds, Natalie Mota, and Lauren Kelly.

Manuscript 1: Systematic Review and Meta-Analysis

Kayla conceptualized and designed this study, conducted literature searches, screened articles, trained and supervised five undergraduate students in article screening, extracted and coded all data, performed all statistical analyses, and interpreted findings. She wrote the full manuscript and incorporated feedback from her supervisor and committee members. Dr. Leslie Roos provided conceptual guidance on study design and iterative feedback throughout manuscript development. Drs. Kristin Reynolds, Natalie Mota, and Lauren Kelly provided detailed, iterative feedback on manuscript drafts. Tia Alsaidi, Rachel Davis, Bhavya Arora, Jessica Trainor, and Kaitlin Loran assisted with article screening. Tia Alsaidi also verified data extracted by Kayla and helped conduct the risk of bias assessment.

Manuscript 2: The Building Emotional Awareness and Mental Health (BEAM) Program

Kayla contributed to the development of the original BEAM trial, alongside a large interdisciplinary team, from which the secondary data were drawn. Her contributions included preparing an ethics application, writing the study protocol (which has been published elsewhere), selecting study measures, informing program design, facilitating weekly telehealth groups for BEAM as part of the clinical team, and serving as a student clinical supervisor for individuals administering the Mini International Neuropsychiatric Interview (MINI) for eligibility purposes. Dr. Roos (Principal Investigator) secured funding for the larger BEAM program alongside co-investigators Drs. Anna MacKinnon, Charlie Rioux, Laurence Katz, Kristin Reynolds, Lauren

Kelly, Tracie Afifi, Aislin Mushquash, Fiona Clement, Mariette Chartier, and Liane Tomfohr-Madsen.

For this secondary data analysis, Kayla conceptualized the study, developed the analytic plan, conducted all statistical analyses, interpreted the findings, and wrote the full manuscript. Dr. Roos supported development of the analysis plan, guided interpretation of findings, and provided detailed feedback on manuscript drafts. Dr's Kristin Reynolds, Natalie Mota, and Lauren Kelly provided detailed, iterative feedback on manuscript drafts. Robert (Bobby) McHardy provided code writing support for statistical analyses.

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LIST OF ABBREVIATIONS USED

ARSU	At-risk Substance Use
ARSU+	At-risk Substance Use and Co-Occurring Depression/Anxiety
ARSU-	At-risk Substance Use Without Co-Occurring Depression/Anxiety
AUDIT	Alcohol Use Disorder Identification Test
BEAM	Building Emotional Awareness and Mental health
CHRIM	Children's Hospital Research Institute of Manitoba
CIHR	Canadian Institutes of Health Research
COM-B	Capability, Opportunity, and Motivation – Behavior Model
COMET	Core Outcome Measures in Effectiveness Trials
CMA	Comprehensive Meta-Analysis
CONSORT	Consolidated Standards of Reporting Trials
COVID–19	Coronavirus Disease 2019
CUDIT-R	Cannabis Use Disorder Identification Test – Revised
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition
FIML	Full Information Maximum Likelihood Estimation
GAD-7	Generalized Anxiety Disorder – 7 Item
MAUQ	mHealth App Usability Questionnaire
MCAR	Missing Completely at Random
MINI	Mini International Neuropsychiatric Interview
MHitEY	Mental Health in the Early Years
PAB	Parent Advisory Board
PHQ–9	Patient Health Questionnaire – 9 Item
PRIME	Partnering for Research Innovation in Mental Health
PRISMA	Preferred Reporting for Systematic Reviews and Meta-Analyses
PROMIS	Patient-Reported Outcomes Measure Information System
PROSPERO	International Prospective Register of Systematic Reviews
PSI-SF	Parenting Stress Index – Short Form
RCT	Randomized Controlled Trial
REB	Research Ethics Board
REDCap	Research Electronic Data Capture
RSE	Recent Stressful Experiences
SPIRIT	Standard Protocol Items: Recommendations for Intervention Trials
SPSS	Statistical Package for the Social Sciences
T0	Enrollment

T1	Pre-Treatment
T2	Post-Treatment
T3	Follow-Up
TAU	Treatment as Usual
UP	Unified Protocol

GLOSSARY

Below are key definitions of terminology used throughout this dissertation.

Term	Definition
At-Risk Substance Use	The use of a substance or substances (e.g., alcohol, cannabis) in a manner that is harmful to oneself. For the purposes of this dissertation, at-risk substance use is defined as scoring above clinical cut-offs on standardized screening tools: the Alcohol Use Disorder Identification Test and the Cannabis Use Disorder Identification Test – Revised.
eHealth	Any mental health or substance use treatment with online supports. Examples of eHealth include video therapy, website, or App.
Mother	Any mother-identifying figure (i.e., biological, adoptive, foster, or stepparent) regardless of sex assigned at birth.
Single-Focus Treatment	A treatment developed to target one primary area of concern (e.g., mental health, substance use), rather than addressing multiple co-occurring issues simultaneously. In this dissertation, single-focus treatments refer to programs developed to treat either mental health or substance use, but not both.
Substance Use	The use of a substance or substances which produce intoxicating effects, such as alcohol and cannabis.

CHAPTER ONE: General Introduction

One in two Canadians will be diagnosed with a mental health disorder by the age of 40 years old (Centre for Addiction and Mental Health, n.d.). Among Canadians who have experienced mental health concerns in the past year, one-third did not seek help (Canadian Mental Health Association, 2023). Documented barriers to accessing mental health treatment include: (a) uncertainty about where to get help, (b) long wait lists, (c) insufficient patient-to-clinician ratios, (d) geographic and demographic disparities (e.g., rural settings, Indigenous populations), and (e) financial constraints (Moroz et al., 2020). Among those who do manage to access mental health treatment, only one in three report that their needs were successfully met by the treatment they received (Centre for Addiction and Mental Health, n.d.). Collectively, these findings suggest most Canadians lack adequate access to high-quality, evidence-based mental health treatments (Canadian Mental Health Association, 2023; Centre for Addiction and Mental Health, n.d.). As such, there is a need for systemic changes to reduce barriers and expand the availability of accessible and evidence-based mental health treatments.

The Growing Burden of Substance Use

Alcohol and cannabis remain the most widely used substances in Canada, with high rates of use likely influenced by shifting societal norms, legal status, and widespread accessibility (Government of Canada, 2021, 2024; Statistics Canada, 2018). Among Canadians aged 15 years or older who used substances before the COVID-19 pandemic, 24% reported increased alcohol use and 34% reported increased cannabis use (Government of Canada, 2022). Although alcohol and cannabis use are not inherently harmful, frequent or heavy use is associated with adverse outcomes including mental health disorders, chronic health conditions (e.g., liver disease, stroke), and memory problems (United States Centers for Disease Control and Prevention, 2025).

Given high prevalence rates, ease of access, and many individuals using substances to cope with emotional distress (Government of Canada, 2021, 2024; Statistics Canada, 2018; Khantzian, 1997; Mariani et al., 2014), alcohol and cannabis use are particularly relevant in mental health contexts. This dissertation therefore focuses on alcohol and cannabis – rather than other substances – to address the most prevalent and socially normalized forms of substance use in Canada. Despite the availability of evidence-based substance use treatments, access remains limited due to factors such as stigma, long wait times, and inadequate availability of specialized care (Farhoudian et al., 2022).

Co-Occurring Mental Health Disorders and At-Risk Substance Use

The rising rates of mental health disorders and at-risk substance use (ARSU; i.e., use of alcohol and/or cannabis, in a manner that is harmful to oneself as defined by a standardized screening tool) are concerning on their own, and are especially troubling given that they frequently co-occur. Individuals with mental health disorders, like depression and anxiety, are more likely to engage in ARSU, and those with ARSU are also at an increased risk of developing mental health disorders (National Institutes on Drug Abuse, 2020). One widely accepted explanation for this bidirectional relationship is self-medication theory, which posits that individuals use substances to cope with mental health symptoms and associated distress, and vice versa (Khantzian, 1997; Mariani et al., 2014). Although substance use can temporarily reduce distress, it is not an effective long-term coping strategy. Substance use may trigger or exacerbate psychiatric symptoms and increase the risk of suicide (Athey et al., 2025; National Institutes on Drug Abuse, 2020). As such, it is important to treat both mental health concerns and ARSU during treatment to reduce the likelihood of negative sequelae (Kelly et al., 2012; Mueser & Gingerich, 2013; Torrens et al., 2012).

As the symptoms of mental health concerns and ARSU often interact and reinforce one another, treating these co-occurring concerns can be challenging and complex. While integrated treatments that target both domains are most effective, many existing treatments target only one primary concern – often without clear guidance on which symptoms should be prioritized (Kelly et al., 2012; Mueser & Gingerich, 2013; Torrens et al., 2012). This can lead to those in need being excluded from public health-based treatments as it is unclear which concern should be addressed first. Evaluating how single-focus treatments perform among individuals with co-occurring concerns may therefore offer insight into their broader clinical utility.

eHealth: A Promising Solution

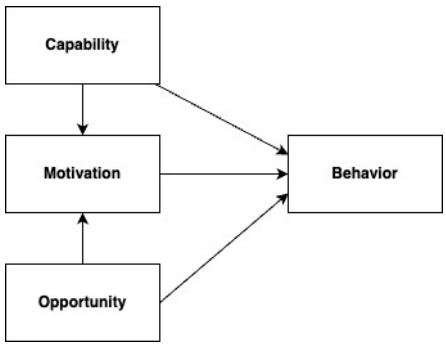
The coronavirus disease 2019 (COVID-19) pandemic brought a major shift in how health services are delivered through digital platforms. eHealth refers to the use of digital technology (e.g., internet, smartphone) to support mental health, substance use, and related domains (World Health Organization, 2023). In a matter of months, eHealth rapidly became the predominant mode of service delivery. The number of published articles on eHealth in mental health settings increased nearly five-fold between 2018 and 2020 (Ellis et al., 2021; Martinez-Martin et al., 2020), reflecting a growing demand for remote treatment and an increased interest in scalable alternatives to in-person treatment.

eHealth holds significant promise in expanding access to treatment for mental health concerns and substance use. In response to pandemic-related physical distancing requirements, substantial infrastructure was developed to support eHealth treatment (Attard et al., 2022; Williams et al., 2022). In 2020, most Canadians had a smart phone (aged 15 to 44; 96-97%) and access to high-speed internet (93.5%), underscoring the potential reach of eHealth treatments relative to traditional in-person treatment (Government of Canada, 2023; Statistics Canada, 2023,

2024). In addition to scalability, eHealth is often perceived by its users as a more accessible and cost-effective option – particularly among underserved populations (Hubley et al., 2016; Lal, 2019). These advantages position eHealth as a promising method to address at least some of the longstanding barriers in mental health and substance use treatment. However, despite its potential, eHealth also presents challenges such as high dropout and low engagement rates (Fleddermann et al., 2021; Linardon & Fuller-Tyszkiewicz, 2020; Shams et al., 2023). Continued research is needed to better understand the effectiveness of eHealth and to identify strategies that address eHealth-related challenges.

Although eHealth treatments vary in structure and content, most share similar components that facilitate behavior change (e.g., personalized feedback, psychoeducation, cognitive strategies, social support). The Capability, Opportunity, and Motivation – Behavior (COM-B) model provides a useful framework by which treatment components impact behavioral outcomes (Michie et al., 2011). According to the model, effective behavior change requires individuals to possess that capability to change (e.g., have the knowledge and skills required), the opportunity to engage in change (e.g., accessible and supportive environments), and the motivation to maintain change (Figure 1). eHealth treatments are uniquely positioned to target each of these domains. For example, eHealth treatments may increase capacity through psychoeducation and practice assignments, opportunity through flexible digital delivery, and motivation through peer support. This framework provides a helpful lens for interpreting how eHealth treatment components may support behavior change and will be revisited in the general discussion to contextualize dissertation findings.

Figure 1. A depiction of the capability, opportunity, and motivation-behavior (COM-B) model



eHealth treatments demonstrate effectiveness in reducing mental health symptoms and substance use. Meta-analyses of randomized controlled trials (RCTs) show that eHealth treatments yield small-to-moderate reductions in both mental health symptoms (i.e., depression and anxiety) and substance use outcomes (i.e., alcohol and cannabis use), though the latter show diminishing effects over time (Chan et al., 2022; MacKinnon et al., 2022; Boumparis et al., 2019; Cadigan et al., 2015; Carey et al., 2009, 2012; Dedert et al., 2015; Donoghue et al., 2014; Hoch et al., 2016; Khadjesari et al., 2011; Olmos et al., 2018; Riper et al., 2011, 2014; Rooke et al., 2010; Sundström et al., 2017; Tait et al., 2013; Tait & Christensen, 2010; Webb et al., 2010). These findings highlight the potential for eHealth to address depression, anxiety, alcohol use, and/or cannabis use – particularly among populations who face barriers to in-person treatments. However, the feasibility of these treatments for individuals with co-occurring mental health concerns and ARSU (ARSU+) is not well understood. This gap is prominent for underserved groups, such as mothers of young children, who often encounter logistical, social, and systemic barriers to accessing in-person treatment (Hudson & Manuel, 2023; Poole & Isaac, 2001). Understanding how single-focused eHealth treatments perform in these contexts is important to improve future treatment efforts for high-risk populations.

The Needs of Mothers with Mental Health Concerns and At-Risk Substance Use

In Canada, 23% of mothers report symptoms consistent with postpartum depression or an anxiety disorder, and approximately 40% report increased substance use compared to pre-pandemic levels (Joyce et al., 2022; Statistics Canada, 2019). Despite this high prevalence, mothers with young children remain underserved by mental health and substance use treatments, in part due to the unique and compounding barriers they face (Poole & Isaac, 2001). These barriers often include a lack of childcare, stigma, fear of judgement, and concerns about involvement with child and family services (Poole & Isaac, 2001). As a result, many mothers may be unable or unwilling to seek treatment, which can contribute to inconsistent parenting, heightened family stress, and, in some cases, involvement with child and family services or risk of child removal (Lander et al., 2013). Mothers with young children are also underrepresented in substance use treatment research, particularly outside the context of pregnancy, contributing to substantial knowledge gaps and limited availability of tailored treatments (Adams et al., 2021; Chou et al., 2020).

eHealth treatments may help address these challenges by providing flexible, remote care that reduces the need for childcare or time away from caregiving duties. Feature such as on-demand modules and increased anonymity may also reduce maternal concerns about stigma, judgement, or involvement with child and family services. Similar online formats have been shown to help address other sensitive issues for mothers, such as breast/chest feeding difficulties (Severinsen et al., 2024). For mothers of young children, these features are salient and may support earlier and more consistent engagement with evidence-based care. However, based on existing reviews, few treatments have been developed specifically for mothers with ARSU

(Joyce et al., 2025; Milligan et al., 2010), let alone eHealth treatments tailored to those with ARSU+.

Clinicians within the Manitoba Perinatal Mental Health Hub[1] have emphasized the urgent need for evidence-based mental health and substance use treatment for mothers across the province. Given the increased and persistent rates of maternal depression, anxiety, and substance use since the onset of the COVID-19 pandemic, this is a timely and important opportunity to examine whether existing eHealth treatments, specifically those targeting mental health concerns or substance use alone, can also benefit mothers with ARSU+ (Ahmad & Vismara, 2021; Chen et al., 2022; Chmielewska et al., 2021; Ghelbash et al., 2022; Hessami et al., 2022; Joyce et al., 2022; Racine et al., 2022; Shorey et al., 2021; Yan et al., 2020).

The Present Dissertation

This dissertation includes two complementary studies that examine the feasibility, clinical utility, and effectiveness of eHealth treatments originally developed to target either mental health or substance use in isolation. Manuscript 1 presents a meta-analysis and systematic review to synthesize extant evidence on eHealth treatments for alcohol and cannabis use, with a focus on moderators of treatment effectiveness. Manuscript 2 reports on a secondary data analysis of two RCTs evaluating an eHealth mental health and parenting treatment (i.e., Building Emotional Awareness and Mental health; BEAM) for mothers of young children, comparing those with ARSU+ to ARSU-. Although the eHealth treatments examined herein were not developed for individuals with ARSU+, both studies explore how single-focus eHealth

[1] The Manitoba Perinatal Mental Health Hub is under development and is currently seeking funding through the Manitoba government to improve perinatal mental health treatment in the province. Clinicians involved include clinical psychologists, psychiatrists, obstetricians, midwives, nurses, academic researchers, community organizations, indigenous partners, individuals with lived experience, and research trainees.

treatments perform in the context of complex treatment needs. Together, these studies provide preliminary insight into the scalability and broader applicability of eHealth treatments for those with ARSU+.

Manuscript 1: Meta-Analysis of eHealth Treatments for Alcohol and Cannabis use

The first manuscript was a meta-analysis and systematic review of RCTs examining eHealth treatments for alcohol or cannabis use.[2] This study aimed to determine the effectiveness of eHealth treatments on alcohol and cannabis use outcomes and examine potential moderators that could help explain variability in treatment effects. Moderators of interest included participant- (e.g., college/university sample, percent female/woman), treatment- (e.g., treatment length, intention-to-treat analysis), and study-level factors (e.g., year of publication, control type), as well as treatment components (e.g., relapse prevention, motivational interviewing). Study screening, data extraction, and coding followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009). Random-effects meta-analyses were used to pool treatment effects. Findings from this study provided insight into the effectiveness of eHealth treatments for alcohol and cannabis use, identified key subgroups for whom eHealth treatments may be most (or least) effective, examined associations between treatment components and effect sizes, and highlighted important gaps in extant literature.

Transitional Chapter

[2] The initial goal of this review was to examine the effectiveness of eHealth treatments on alcohol and cannabis use in mothers of young children. However, preliminary database searches revealed insufficient research published on this population. As a result, the scope of this meta-analysis was broadened to include eHealth treatments for alcohol and cannabis use across all populations.

Following manuscript 1, a transitional chapter conceptually explores the link between the meta-analysis and a secondary data analysis of BEAM. This chapter integrates findings from manuscript 1 and a related systematic review by Joyce et al. (2025) which examined the effectiveness of psychological treatments for maternal substance use disorders on substance use and mental health outcomes. Together, these reviews highlight the lack of effective eHealth treatments for individuals with ARSU+, particularly mothers of young children. This chapter reflects on the methodological limitations and patterns observed across trials in manuscript 1, including the underrepresentation of maternal samples and the limited number of studies examining substance use treatment in conjunction with mental health components. Together, these findings support the exploration of whether existing eHealth treatments, such as BEAM, may be feasible and associated with symptom improvement among mothers with ARSU+, even when substance use is not the explicit treatment focus.

Manuscript 2: Secondary Data Analysis of the BEAM eHealth Treatment for Mothers with and Without ARSU

Manuscript 2 is a secondary data analysis of two RCTs examining BEAM, an eHealth mental health and parenting treatment developed for mothers of infants and toddlers. Although BEAM was not designed to directly address ARSU, it incorporates several treatment components that may be relevant for mothers with ARSU such as psychoeducation, cognitive strategies, emotion regulation, and peer support. This manuscript assessed whether BEAM engagement, implementation, and clinical outcomes (i.e., depression, anxiety, sleep disturbance, anger, parenting stress) differed within the BEAM treatment arm between mothers with ARSU+ versus ARSU-. Linear mixed models were used to analyze symptom change over time and group differences. This study provides preliminary insights into how mothers with ARSU+ engage with

and respond to BEAM, helping to inform feasibility efforts. Findings highlight implementation outcomes and patterns of symptom change across subgroups, contributing to the early evidence base for adapting eHealth treatments for underserved maternal populations.

Toward Scalable and Inclusive eHealth Treatments

Taken together, this dissertation addresses a timely question: how well do single-focus eHealth treatments perform among individuals with ARSU+? This dissertation contributes to a growing body of literature on how single-focus eHealth treatments may function in a more complex, real-world context. Findings will provide preliminary knowledge on how mothers with ARSU+ engage with BEAM and clinical symptom trajectories. This dissertation will also offer actionable insights into how eHealth treatments could be adapted to better serve high-need and underserved populations, namely mothers with ARSU+. In doing so, this dissertation helps lay the foundation for expanding access to scalable, inclusive, and responsive eHealth treatments.

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CHAPTER TWO: Meta-Analysis and Systematic Review

Introduction

Despite increasing rates of alcohol and cannabis use in Canada (Government of Canada, 2022), access to substance use treatments remain limited due to limited resources resulting in prolonged waitlists, high costs, and insufficient client-to-provider ratios (Moroz et al., 2020). Individuals struggling with their substance use often require comprehensive care that includes medical treatments, behavioral interventions, and harm reduction strategies (Volkow & Blanco, 2023). These treatments are often scarce, inconsistently available, or difficult to access due to regional disparities, limited funding, and a shortage of trained professionals (Government of Canada, 2019; Urbanoski, 2017).

To address these accessibility challenges which were further exacerbated by the coronavirus disease 2019 (COVID-19) pandemic, researchers and healthcare providers have increasingly turned to eHealth treatments, i.e., using technology to support the delivery of healthcare (World Health Organization, 2025). eHealth treatments, such as web- and phone-based treatments, could potentially improve mental health outcomes on a large scale given their scalability and cost-effectiveness (Ondersma & Walters, 2020; Puleo et al., 2021). These advantages are particularly relevant for individuals who face barriers to in-person care, such as those living in rural/underserved areas, with demanding work schedules and/or caregiving responsibilities, and financial constraints that may limit attendance and engagement (Bhatti et al., 2022; Government of Canada, 2019). However, issues such as high dropout rates, privacy and confidentiality concerns, and technological difficulties may hinder the widespread adoption of eHealth (Fleddermann et al., 2021; Shams et al., 2023). It also remains unclear whether eHealth treatments replicate treatment effects observed in traditional in-person care or align with the

treatment preferences of individuals seeking support for their substance use (Mark et al., 2022; Ngo et al., 2022; Tauscher et al., 2023). Despite these uncertainties, providers across a range of substance use treatment settings report positive views toward eHealth treatments, highlighting their potential feasibility for clinical implementation (Molfenter et al., 2021; Pusnik et al., 2024). These studies suggest that eHealth is perceived as acceptable and promising within the broader substance use treatment field. Overall, eHealth treatments may present a promising approach for individuals seeking substance use care.

Effectiveness of eHealth Treatments: Current Evidence and Limitations

Reviews suggest eHealth treatments targeting alcohol and cannabis are feasible, acceptable, and associated with moderate-to-high user satisfaction (Bennett et al., 2020; Nesvåg & McKay, 2018; Ojeahere et al., 2022; Sedrati et al., 2021). However, their effectiveness in reducing alcohol and cannabis use remains unclear. Systematic and non-systematic reviews report mixed findings with some suggesting positive effects, while others suggest minimal or no effects (Berman et al., 2016; Bewick et al., 2008; Copeland & Martin, 2004; Elliott et al., 2008; Hutton et al., 2020; Kazemi et al., 2021; Leeman et al., 2015; Meredith et al., 2015; Newman et al., 2011; White et al., 2010). When examining only reviews that included randomized controlled trials (RCTs), however, support for eHealth treatments was found (Elliott et al., 2008; White et al., 2010). Meta-analyses and umbrella reviews examining eHealth treatments similarly report small-to-moderate effects on alcohol and cannabis use (Boumparis et al., 2019; Cadigan et al., 2015; Carey et al., 2009, 2012; Dedert et al., 2015; Donoghue et al., 2014; Hoch et al., 2016; Khadjesari et al., 2011; Olmos et al., 2018; Riper et al., 2011, 2014; Rooke et al., 2010; Sundström et al., 2017; Tait et al., 2013; Tait & Christensen, 2010; Webb et al., 2010). Only one meta-analysis reported non-significant effects, however, this meta-analysis was limited in scope,

focusing solely on text message-based eHealth treatments for risky drinkers (Bendtsen et al., 2021). Importantly, treatment effects are often reported at post-treatment but tend to diminish over time, i.e., by follow-up, which raises concerns about long-term efficacy. These inconsistencies highlight the need for a deeper understanding of the factors influencing eHealth effectiveness, particularly which populations benefit most and under what conditions eHealth treatments produce sustained outcomes. Addressing these gaps requires a further understanding of the role key moderators play in shaping eHealth treatment effects.

Factors Influencing eHealth Treatment Effectiveness

Variability in eHealth treatment effectiveness may stem from previous reviews which are often narrow in scope, focusing on specific populations (e.g., college/university students; Carey et al., 2009, 2012; Elliott et al., 2008; Leeman et al., 2015), a single treatment modality (e.g., smartphone apps, text messages, or computer-based treatments; Bendtsen et al., 2021; Meredith et al., 2015; Olmos et al., 2018; Tait et al., 2013), as well as one specific alcohol or cannabis use outcome (Donoghue et al., 2014; Khadjesari et al., 2011; Tait & Christensen, 2010). Although these reviews provide valuable insights, they lack generalizability to individuals using alcohol and cannabis, limit findings to specific treatment modalities, and yield results that vary depending on the outcome being examined. Given these gaps, further research is needed to examine how treatment components as well as participant-, treatment-, and study-level characteristics may moderate eHealth treatment effectiveness.

Several demographics may influence eHealth treatment efficacy. For example, research suggests 1) individuals who are married or in a relationship show greater reductions in alcohol and cannabis use following treatment, potentially due to social support and relationship-based protective effects (Fleming et al., 2010; Salvatore et al., 2020); 2) younger individuals have

higher rates of alcohol and cannabis use (Vasilenko et al., 2017); and 3) females/women enter treatment with greater psychiatric, medical, and employment impairment (Hernandez-Avila et al., 2004), higher rates of co-occurring mental health disorders (Khan, Okuda, et al., 2013; Khan, Secades-Villa, et al., 2013), and shorter latency between first substance use and the development of a substance use disorder (Khan, Secades-Villa, et al., 2013). Identifying moderators, i.e., factors that influence treatment efficacy, is important for understanding when and for whom eHealth treatments are most effective, as moderation analyses provide a nuanced understanding of effectiveness by determining whether specific variables enhance or diminish effects.

Key Areas for Advancement

To improve our knowledge on eHealth treatments for alcohol and cannabis use, there is a need to update and expand upon previous reviews in several key ways.

1. *Incorporate recent technological advancements*: Given rapid developments in eHealth treatments – particularly following their widespread adoption during the COVID-19 pandemic – a meta-analysis synthesizing the most recent evidence is needed (Adetunji et al., 2022; Cantor et al., 2022).
2. *Improve generalizability*: Many existing reviews focus on narrow populations or specific treatment modalities. A broader meta-analysis should include diverse populations (e.g., clinical and non-clinical samples), varied treatment formats (e.g., phone, computer), and different substance use outcomes (e.g., reduction in quantity, frequency). Expanding inclusion criteria will ensure findings are more representative of those who use alcohol and cannabis.

3. *Identify risk and protective factors*: Investigating participant-, treatment-, and study-level moderators could refine and improve eHealth treatment approaches for those who use substances (Kopak et al., 2017; Lu et al., 2023; Riper et al., 2018).
4. *Analyze Treatment Components*: Existing reviews have identified key treatment components that influence treatment effects (Benzies et al., 2013; Joyce et al., 2025), but these reviews are not specific to eHealth treatments. In fact, neither review included an eHealth treatment study. Gaining a better understanding of which treatment components are more (or less) effective could improve treatment outcomes.

The Current Study

A meta-analysis was conducted to evaluate the effectiveness of eHealth treatments for alcohol and cannabis use, substances that are legal in Canada yet remain major public health concerns due to their widespread use (Minister of Justice, 2018). As eHealth treatments are becoming increasingly popular, it is critical to determine not only their overall effectiveness, but also which factors moderate treatment effects, to inform future treatment development and implementation.

Research Questions and Hypotheses

This study aimed to 1) synthesize the current evidence on eHealth treatment effectiveness in reducing alcohol and cannabis use and 2) examine key moderators to identify for whom and under what conditions eHealth treatments are more (or less) effective. To address gaps in the extant literature, the following were proposed:

Pre-Planned Hypotheses

1. eHealth treatments will be effective in reducing alcohol and cannabis use at post-treatment and follow-up.

2. eHealth treatments will show greater improvements in alcohol and cannabis use outcomes among studies with a higher proportion of individuals married/in a relationships and male/men at post-treatment and follow-up.

Post-Hoc Analyses (Pincus et al., 2011)

3. Investigate whether participant-level factors moderate eHealth treatment effectiveness (i.e., sample mean age, percentage White/Caucasian, percentage female/women, college/university sample, inclusion of only individuals with ARSU, relationship status).
4. Investigate whether treatment-level factors moderate eHealth treatment effectiveness (i.e., treatment length, treatment modality, follow-up duration, and intention-to-treat analysis).
5. Investigate whether study-level factors moderate eHealth treatment effectiveness (i.e., publication year, continent of publication, and control type).

Exploratory Analyses

6. Identify which treatment components moderate treatment effectiveness.
7. Assess the methodological quality of RCTs examining eHealth treatments for alcohol and cannabis use.

Methods

To improve the precision of effect size estimates across trials and to examine potential moderators of treatment effectiveness, a meta-analysis was conducted. This review adheres to methods outlined in the Cochrane Collaboration's Handbook (Higgins et al., 2024) and the Preferred Reporting for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009). The protocol was registered on the International Prospective Register of Systematic Reviews (PROSPERO) through the University of York Centre for Reviews and Dissemination

prior to commencement (CRD42023445723). Protocol deviations with rationale are described throughout.

Article Identification

A literature search was conducted on July 1, 2023, in the following databases: PsycINFO, PsycARTICLES, PubMED, MEDLINE, and Web of Science. These databases were selected based on consultation with a librarian to ensure coverage of relevant medical and psychological literature. A publication date limit of January 1, 2000, onward was applied to ensure relevance to current digital health technology (see Appendix A for the search terms). Duplicate articles were excluded prior to screening. The remaining articles were screened independently by two reviewers. Titles and abstracts were screened first, followed by full text screening (see below for inclusion/exclusion criteria). Disagreements between reviewers were discussed to consensus during weekly team meetings. The reference lists of included articles were also screened to identify additional articles of potential relevance. The screening steps outlined above were followed for articles identified via the reference list search.

Inclusion/Exclusion Criteria

Studies were eligible if they: were published in English in a peer-reviewed journal (to ensure methodological rigor); were original research (e.g., no protocols, review papers); were published on or after January 1, 2000; used RCT methodology with at least one treatment and control arm; examined an eHealth treatment targeting substance use; had at least one treatment that was 100% online (e.g., control could be in-person); assessed alcohol and/or cannabis use as an outcome; and reported pre- and post-treatment alcohol and/or cannabis use data.

Several criteria were added following pre-registration in response to methodological and conceptual issues evident during article screening. First, articles were required to include

participants who had used alcohol and/or cannabis at least once, as treatment effectiveness could not be meaningfully assessed in individuals with no history of substance use. This criterion excluded prevention studies targeting those who were abstinent or have never used substances. Second, treatments had to directly target the individual using substances, rather than their family or close friends, to align with the study's conceptual aim of evaluating treatment effectiveness for individuals using substances. Third, studies were required to report unadjusted data,[3] as there is no consensus on synthesizing adjusted and unadjusted effect sizes in meta-analyses (Voils et al., 2011). When only adjusted data were presented, the author was contacted to obtain unadjusted data (see Data Collection and Processing heading below).[4] Some suggest using a subgroup analysis to analyze effect size differences between unadjusted and adjusted results, but ten studies are required to conduct this analysis which was not possible here (Higgins et al., 2024; Voils et al., 2011). Fourth, studies were also no longer restricted to participants meeting criteria for at-risk substance use (ARSU) based on standardized substance use measure scores above clinical cut-offs. Our ability to conduct meaningful moderator analyses would have been hindered, as only 37 studies were restricted to participants meeting ARSU criteria. This amended criterion therefore ensured sufficient power to conduct moderator analyses (Pincus et al., 2011) and was included as a moderator instead. Finally, this meta-analysis includes data from post-treatment and the first available follow-up only, even when additional long-term follow-up data were reported. Studies reporting only long-term follow-ups were excluded due to substantial variability in the timing of data collection (e.g., additional follow-ups conducted years later),

[3] Unadjusted data does not account for statistical corrections for confounding variables.
[4] Following these steps, only adjusted data were available for two otherwise eligible studies (Mason, Zaharakis, Moore, et al., 2018; Mason, Zaharakis, Russell, et al., 2018).

which would have introduced heterogeneity and limited the interpretability of pooled effects (Guevara et al., 2004).

Data Extraction and Management

Data were extracted from included articles in duplicate to minimize error and enhance reliability of the extracted data. The following were extracted from each article:

a. *Study information*: author name(s), study title

b. *Treatment and control characteristics*: sample size, recruitment and retention rates

c. *Alcohol and cannabis use outcomes:* mean, standard deviation, sample size (or sufficient data to calculate these values). Alcohol and cannabis use were measured using a range of validated and self-report measures, depending on the study. A full summary of measures is provided in Appendix B.

d. Moderators:

    1. *Participant-level factors*: mean sample age (years), percentage of White/Caucasian participants in the sample, percentage of females/woman in the sample, college/university sample (1 = yes, 0 = no), inclusion of only individuals with ARSU (1 = yes, 0 = no), and relationship status (1 = married/in a relationship, 0 = other)

2. *Treatment-level factors*: treatment length (days)[5], treatment modality (0 = computer, 1 = telephone), follow-up duration (days), intention-to-treat analysis[6] (1 = yes, 0 = no).
3. *Study-level factors*: publication year, continent of publication (1 = North America, 0 = other), and control type (1 = active, 0 = inactive; Higgins et al., 2024).[7]

e. *Key treatment components*: Using bottom-up coding (Braun & Clarke, 2006), treatment descriptions were reviewed in full and deconstructed into conceptual components to analyze their impact on treatment effects (e.g., personalized normative feedback, psychoeducation). Coding was inductive and based on content described within each treatment, with component definitions refined using relevant literature. Each component was coded as present or absent for each study based on these operational definitions. For example, harm reduction was coded as present when a treatment included strategies aimed at minimizing risks associated with substance use

[5] To determine treatment length, several methods were used. First, if treatments of differing lengths were combined (see below for further information), the longest treatment length was used. Treatment length was also assumed to be one day when the treatment description included "single session" or was completed during one visit.

[6] A method for analyzing results of a RCT where all participants who were randomized are included in the statistical analysis (McCoy, 2017). An intention-to-treat moderator was only endorsed if explicitly stated in the article.

[7] An inactive control was defined as a study designed to estimate the eHealth treatments absolute effect, that is whether those receiving the treatment benefited compared to those not receiving a treatment (e.g., participants receiving no treatment, waitlist controls, assessment-only, treatment as usual (TAU) when compared to the treatment/TAU; Higgins et al., 2024). Active controls were defined as a study that estimates the treatments relative effect (i.e., is the eHealth treatment more effective than another treatment; Karlsson & Bergmark, 2015). When data from two or more control groups were pooled (see below for further information), the overall control type was defined as an 'active control' if at least one active control was present.

(e.g., moderation, safer use), even if abstinence was not required. Coding was conducted by the first author and reviewed for consistency by a second individual.

Data Analysis

Agreement on Study Identification

Percent agreement between raters and Cohen's kappa, a measure of inter-rater reliability (Cohen, 1968), was calculated for title/abstract and full text screening to ensure reliability and consistency between raters. Cohen's kappa was interpreted as follows: κ = .10-.20 (no agreement), κ = .21-.39 (weak agreement), κ = .40-.59 (minimal agreement), κ = .60-.79 (moderate agreement), κ = .80-.90 (strong agreement), and κ > .90 (almost perfect agreement; McHugh, 2012).

Data Collection and Processing

The corresponding authors of 70 studies were contacted to gather 1) information to determine eligibility, 2) required data that was missing, or 3) unadjusted data. Alternative contact information for the corresponding author was identified if they could not be reached by that provided in the article (e.g., searches of ResearchGate, LinkedIn, Google). Co-authors were subsequently contacted if the corresponding author could not be reached. Authors (and co-authors where appropriate) were contacted monthly for up to five months before studies were excluded due to missing data. Twenty-one articles were excluded following contact, as authors no longer had access to the data or the study did not meet inclusion/exclusion criteria. Three studies were also excluded as two did not respond to data requests and one could not be successfully contacted (Bock et al., 2016; Chander et al., 2021; Weaver et al., 2014).

Available data was used to calculate required statistics when not published in the original study (see Appendix C for the equations used). When studies had multiple treatment or control

groups, only conditions directly related to alcohol or cannabis use were analyzed. Treatment and control groups were pooled according to recommendations from the Cochrane Collaboration, which includes pooling means and standard deviations while summing sample sizes (when applicable; Higgins et al., 2024).

Meta-Analysis

Meta-analyses and moderation analyses were conducted using the Comprehensive Meta-Analysis (CMA) Software, Version 4 (Borenstein et al., 2022). Pooled effect sizes were calculated using random effects models as between-study heterogeneity was expected (e.g., different researchers, populations, and eHealth treatments; Cuijpers, 2016) and was deemed the most appropriate model based on a standardized decision-making process (Borenstein et al., 2021; Tufanaru et al., 2015). This meta-analysis compared alcohol or cannabis use outcomes between treatment and control groups at post-treatment and the first follow-up.[8] Best-practices suggest meta-analytic results only draw meaningful conclusions if five or more studies are included (Myung, 2023). As such, meta-analyses were only conducted when outcomes and moderators were present in five or more studies. Effect sizes and 95% confidence intervals for each study were calculated using Hedges *g*, a standardized effect size to examine differences between two group means (Higgins et al., 2024). Hedges *g* includes a correction for small sample bias and is appropriate when synthesizing studies with small or unequal sample sizes, making it more accurate than alternative effect size calculations (Higgins et al., 2024; Taylor & Alanazi, 2023). Hedges *g* was interpreted as follows: $g = .20$ (small effect), $g = .50$ (medium effect), and $g = .80$ (large effect; Hedges, 1981). Effect sizes were reported with and without outliers, if

[8] Based on recommendations not to conduct pre-post comparison meta-analyses (Cuijpers et al., 2017).

applicable and presented in forest plots. Outliers were identified using the CMA software which flags studies whose effect sizes differ substantially from the overall model. This is accomplished using standardized residuals for each study, where studies with a standardized residual of ±1.96 are considered outliers as they fall beyond the 95% CI for the normal distribution. As outlined by the Cochrane Collaboration, $\alpha < .05$ indicated significance (Higgins et al., 2024). Publication bias was assessed using Egger's Test (Egger et al., 1997), funnel plot inspection, and the trim-and-fill method (Duval & Tweedie, 2000).

Heterogeneity was examined using the I^2 index, Cochran's Q, and the prediction interval. The I^2 index determined what proportion of variation across studies reflected heterogeneity rather than chance (Borenstein, 2022) and is interpreted as: 0–40% (heterogeneity may not be important), 30–60% (moderate heterogeneity), 50–90% (substantial heterogeneity), and 75 – 100% (considerable heterogeneity; Higgins et al., 2024). Cochran's Q assessed the degree of heterogeneity among included studies, where higher scores suggest greater result variation across studies (West et al., 2010). Finally, prediction intervals allowed for clinical interpretation of heterogeneity by providing an estimate of the true effect (Borenstein et al., 2009; IntHout et al., 2016). Together these three heterogeneity measures provide a nuanced understanding of the statistical and clinical relevance of heterogeneity.

Moderator Analyses.[9] Subgroup analyses and meta-regressions were conducted using pre-planned and post-hoc/exploratory analyses as recommended by Pincus et al. (2011).

Subgroup analyses examined whether effect sizes differed between categorical groups (Richardson et al., 2019). Analyses were conducted using mixed effects models (i.e., random effects within and fixed effects between subgroups; Borenstein & Higgins, 2013). Subgroup

[9] Moderator analyses were only conducted when moderators varied across studies.

analyses were conducted with the following variables: intention-to-treat analysis, treatment modality, and all treatment components. Post-hoc subgroup analyses were also conducted to examine potential sources of heterogeneity based on clinically and conceptually relevant sample or study characteristics. College/university samples were examined given the overrepresentation of students in psychological research due to convenience sampling (Hanel & Vione, 2016). This analysis therefore explored whether treatment effects generalize beyond this commonly studied subgroup. Studies including only those with ARSU were analyzed as a moderator to assess whether targeting high-risk groups influenced treatment effects. Finally, control type (active versus inactive) was also examined, as the comparison condition can substantially impact effects. Using active controls, rather than inactive controls, can reduce between-group differences which may contribute to variability in treatment effects.[10]

Meta-regression, using the Hartung-Knapp method, examined associations between effect size and continuous moderating variables (Higgins et al., 2024; Inthout et al., 2014). The Hartung-Knapp method was used as it improves accuracy when heterogeneity is high, which was observed here (Inthout et al., 2014). The following continuous variables were examined: percentage of the sample married or in a relationship and identifying as female/woman. Post-hoc moderation analyses were also conducted using mean sample age, percentage of White/Caucasian participants in the sample, year of publication, treatment length, and follow-up duration.[11] Mean sample age was included due to differences in substance use patterns and treatment response across the lifespan (Vasilenko et al., 2017). The percentage of

[10] Socioeconomic status ($\leq$ \$62,900 versus > \$62,900) could not be examined as there were an insufficient number of studies reporting the same.
[11] Co-occurring disorder load (cumulative count) and percentage of parents in the sample could not be examined as there were an insufficient number of studies reporting the same.

White/Caucasian participants in the sample was examined post-hoc to explore whether effects differed in samples that have historically had greater access to substance use treatment. This was based on evidence suggesting racialized populations often face reduced treatment access and outcomes compared to White/Caucasian individuals (Public Health Ontario, 2022). Year of publication was assessed to determine whether effect sizes have changed over time, potentially reflecting advancements in treatment design, implementation, and technology. Finally, treatment length and follow-up duration were examined to evaluate whether dose and the timing of outcome assessments impact treatment effects.

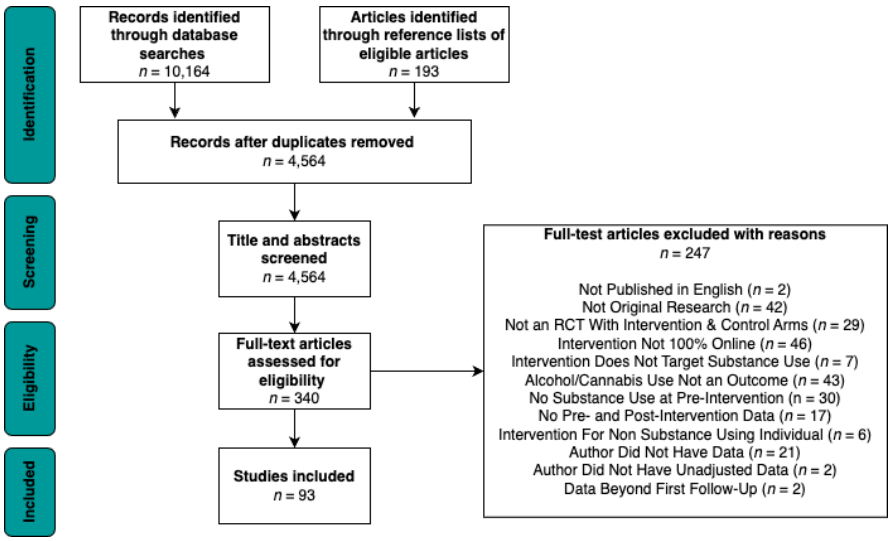
Risk of Bias Assessment

The Cochrane Collaboration's Risk of Bias Tool for RCTs was used to determine the internal validity of included studies (Higgins et al., 2024). This risk of bias tool assessed the following criteria for each study: 1) adequate generation of allocation, 2) concealment of allocation to conditions, 3) blinding of assessors, 4) incomplete outcome data, and 5) selective data reporting. Each criterion was judged as low, high, or unclear risk of bias by two independent reviewers and disagreements were discussed to consensus. No studies were excluded based on the Risk of Bias Assessment results.

Results

A total of 10,357 articles were identified, 10,164 through database searches and 193 through reference list screening of eligible articles (Figure 2). After duplicate removal, 4,564 articles remained. The full text of 340 articles underwent screening. Ninety-three articles met inclusion criteria and are included here (see Appendix D for citations). Inter-rater reliability was moderate-to-strong and excellent percent agreement was obtained at the title/abstract ($\kappa = .68$; 97.00%) and full text level ($\kappa = .88$; 95.38%).

Figure 2. Preferred reporting for systematic review and meta-analyses (PRISMA) flow diagram



Participant Characteristics

See Table 1 for participant characteristics. A total of 51,833 individuals participated across eligible studies, with 28,990 in treatment and 22,843 in control groups. The average participant age was 27.5 years old, and most participants were female/woman (52.3%) White/Caucasian (66.5%), and single (59.9%). Thirty-seven studies (39.8%) included only participants with ARSU, while 41 studies (44.1%) were composed entirely of college/university students. Most articles were published in North America (k = 54.33), followed by Europe (k = 31.83), Oceania (k = 6.33), and unrestricted (k = .5). Articles were published between 2004 and 2023, with the highest number of publications in 2014 (k = 10), 2018 (k = 8), and 2022 (k = 7; Figure 3).[12]

[12] Only one included study targeted alcohol use during the postpartum period (Ondersma et al., 2007).

Table 1. Participant demographics

Author	Continent of Publication	Baseline Sample Size (*N*)	Mean Age in years (*M*)	Female/ Woman (%)	Married/ In a Relationship (%)	White/ Caucasian (%)	Measure for ARSU	College/ University Sample
Agyapong et al., 2012	Europe	54	48.6	53.7%	66.7%	-	Y	N
Andersson, 2015	Europe	1,422	23.2	40.8%	-	-	Y	Y
Arnaud et al., 2016	Europe	1,449	16.4	18.7%	-	-	Y	N
Augsburger et al., 2022	Europe	589	37.9	48.9%	-	-	Y	N
Barnett et al., 2007	North America	225	18.8	51.1%	-	75.6%	N	Y
Baumgartner et al., 2021	Europe	575	28.3	29.4%	-	-	N	N
Becker et al., 2014	Europe	325	29.8	20.9%	-	-	N	N
Bertholet et al., 2015	Europe	737	20.8	0%	-	-	Y	N
Bewick et al., 2010	Europe	1,112	21.5	73.4%	-	92.0%	N	Y
Blankers et al., 2011	Europe	205	42.2	50.7%	-	-	Y	N
Blow et al., 2017	North America	386	31.2	55.5%	29.3%	39.2%	Y	N
Boß et al., 2018	Europe	432	47.0	59.3%	61.6%	-	Y	N
Bonar et al., 2022a	North America	955	20.4	54.5%	4.6%	62.6%	Y	N
Bonar et al., 2022b	North America	149	21.0	55.7%	-	9.4%	N	N
Bonar et al., 2023	North America	41	21.7	63.3%	1.7%	73.3%	N	N
Boyle et al., 2022	North America	499	29.9	100%	49.2%	53.7%	N	N
Braitman et al., 2018	North America	537	19.7	67.4%	25.1%	48.8%	N	Y
Brendryen et al., 2014	Europe	244	38.0	33.2%	-	-	Y	N
Buckner et al., 2020	North America	63	19.1	84.1%	-	-	N	Y
Butler et al., 2009	North America	84	20.2	65.5%	-	91.7%	N	Y
Cadigan et al., 2019	North America	130	21.0	71.0%	-	92.3%	N	Y
Chiauzzi et al., 2005	North America	215	19.9	54.0%	-	73.2%	N	Y
Cunningham et al., 2009	North America	185	40.1	47.0%	51.4%	-	Y	N
Cunningham et al., 2012	North America	170	45.2	40.6%	39.4%	-	Y	N
Cunningham et al., 2021	North America	744	35.8	56.3%	44.0%	-	Y	N
Deady et al., 2016	Oceania	104	21.7	59.6%	-	-	Y	N
Delrahim-Howlett et al., 2011	North America	150	26.3	100%	28.0%	34.0%	N	N
Donovan et al., 2015	North America	319	21.4	73.0%	8.2%	77.4%	N	Y
Doumas et al., 2009	North America	61	19.2	27.6%	-	85.5%	N	Y
Doumas et al., 2011	North America	56	19.2	39.0%	-	88.0%	N	Y
Elliot et al., 2014	North America	162	19.3	52.0%	-	78.0%	N	Y
Freyer-Adam et al., 2018	Europe	961	41.3	25.1%	68.2%	-	Y	N
Gajecki et al., 2014	Europe	983	24.7	51.7%	-	-	Y	Y
Gajecki et al., 2017	Europe	330	25.4	69.1%	-	-	N	Y

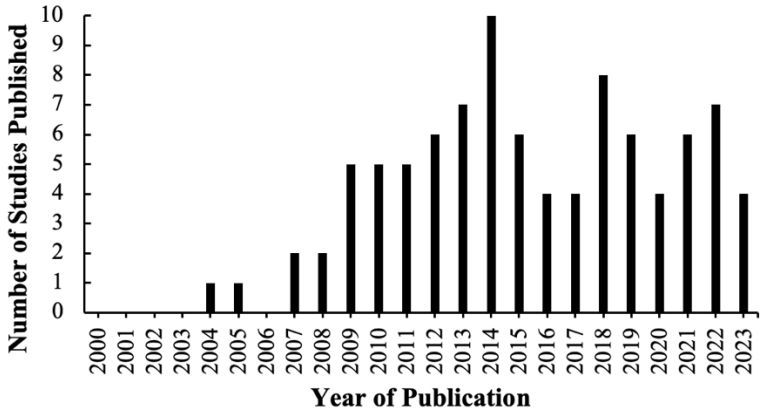
Author	Continent of Publication	Baseline Sample Size (*N*)	Mean Age in years (*M*)	Female/ Woman (%)	Married/ In a Relationship (%)	White/ Caucasian (%)	Measure for ARSU	College/ University Sample
Geisner et al., 2015	North America	254	20.1	62.4%	-	59.7%	Y	Y
Gex et al., 2023	North America	63	20.0	63.6%	-	61.9%	N	Y
Goodness et al., 2020	North America	49	25.5	51.0%	-	77.6%	N	Y
Gryczynski et al., 2021	North America	300	16.3	54.3%	44.0%	2.3%	Y	N
Hansen et al., 2012	Europe	1,380	NR	44.9%	69.6%	-	N	N
Helzer et al., 2008	North America	338	46.0	35.8%	55.6%	97.0%	Y	N
Hester et al., 2009	North America	73	50.4	56.0%	-	79.0%	Y	N
Hester et al., 2012 – *Study 1*	North America	130	20.4	37.5%	-	61.5%	N	Y
Hester et al., 2012 – *Study 2*	North America	81	20.2	43.9%	-	46.9%	N	Y
Ingersoll et al., 2018	North America	71	27.8	100%	-	63.4%	N	N
Johansson et al., 2021a	Europe	1,169	45.0	56.7%	37.6%	-	Y	N
Johansson et al., 2021b	Europe	301	50.0	38.2%	43.0%	-	Y	N
Johnson et al., 2018	Oceania	960[1]	44.1	74.9%	-	-	Y	N
Kypri et al., 2009	Oceania	2,435	19.7	45.3%	-	-	Y	Y
Kypri et al., 2013	Oceania	1,789	20.2	65.5%	-	0%	Y	Y
Kypri et al., 2014	Oceania	3,422	20.2	57.5%	-	-	Y	Y
LaBrie et al., 2013	North America	1,850	19.9	60.2%	-	50.7%	N	Y
Lee et al., 2010	North America	341	18.0	54.6%	-	75.7%	N	Y
Lee et al., 2021	North America	142	22.8	69.7%	14.3%	-	N	Y
Leeman et al., 2016	North America	90	19.9	62.5%	-	62.3%	N	Y
Lewis et al., 2014	North America	359	20.4	57.6%	52.1%	54.7%	N	Y
Liu et al., 2019	Oceania	41[1]	21.9	65.0%	-	-	N	Y
Mason et al., 2014	North America	18	19.2	55.6%	-	66.7%	Y	Y
Mello et al., 2008	North America	425	29.5	39.0%	-	72.0%	N	N
Muench et al., 2017	North America	133	43.2	74.9%	-	93.5%	N	N
Murphy et al., 2010	North America	133	18.6	49.6%	-	65.4%	N	Y
Neighbors et al., 2004	North America	229[1]	18.5	58.7%	-	79.5%	N	Y
Neighbors et al., 2010	North America	818	NR	57.6%	-	65.3%	N	Y
Olthof et al., 2023	Europe	378	27.5	30.7%	-	-	N	N
Ondersma et al., 2007	North America	98[1]	25.1	100%	7.5%	-	N	N
Palfai et al., 2014	North America	123[1]	19.7	-	-	87.0%	N	Y
Postel et al., 2010	Europe	156	45.3	53.8%	-	-	N	N
Riggs et al., 2018	North America	227	20.0	49.0%	-	85.6%	N	Y
Rooke et al., 2013	Oceania, Europe, North America	230	31.0	38.7%	-	-	N	N
Rose et al., 2017	North America	1,705	-	52.0%	55.5%	95.0%	Y	N

Author	Continent of Publication	Baseline Sample Size (*N*)	Mean Age in years (*M*)	Female/ Woman (%)	Married/ In a Relationship (%)	White/ Caucasian (%)	Measure for ARSU	College/ University Sample
Russell et al., 2022	North America	101[1]	20.3	42.7%	-	77.1%	Y	N
Satre et al., 2019	North America	413	49.4	3.1%	43.8%	62.7%	N	N
Schaub et al., 2015	Europe	308	29.8	24.7%	-	-	N	N
Schaub et al., 2019	Europe	311	33.1	27.0%	-	-	N	N
Schluter et al., 2022	North America	123	30.9	47.0%	33.3%	82.5%	Y	N
Sinadinovic et al., 2020	Europe	303	27.4	32.7%	13.9%	-	N	N
Steers et al., 2016	North America	165[1]	23.3	82.0%	-	46.0%	N	Y
Strickland et al., 2019	North America	444[1]	34.3	51.1%	-	79.1%	Y	N
Suffoletto et al., 2012	North America	45	21.0	64.0%	-	-	Y	N
Suffoletto et al., 2015	North America	765	21.9	65.4%	-	49.2%	Y	N
Sundstrom et al., 2020	Europe	166	52.9	51.2%	73.5%	-	Y	N
Teeters et al., 2018	North America	76	22.6	64.5%	-	52.4%	N	Y
Tello et al., 2018	Europe	122	19.8	79.4%	-	-	Y	Y
Tensil et al., 2013	Europe	595	29.4	38.8%	-	-	Y	N
Tossmann et al., 2011	Europe	1,292	24.7	29.5%	-	-	N	N
Van Dessel et al., 2023 – *Study 1*	Europe	193	46.7	25.9%	-	-	N	N
Van Dessel et al., 2023 – *Study 2*	Unrestricted	282	38.3	28.4%	-	-	N	N
Voogt et al., 2013a	Europe	609	17.3	40.1%	-	-	N	N
Voogt et al., 2013b	Europe	907	20.8	38.9%	-	-	N	Y
Voogt et al., 2014	Europe	907	20.8	39.7%	-	-	N	Y
Wagener et al., 2012	North America	152	20.9	45.4%	-	84.6%	N	Y
Wallace et al., 2011	Europe	7,935	38.0	57.3%	61.7%	84.0%	Y	N
Walton et al., 2013	North America	328	16.3	66.5%	-	-	N	N
Wirtz et al., 2022	Europe	108	33.8	60.0%	-	-	N	N
Witkiewitz et al., 2014	North America	94	20.5	27.7%	-	71.3%	N	Y
Young et al., 2019	North America	125	21.0	70.4%	-	44.5%	N	Y

- = Not Reported; Y = Yes; N = No

[1]Data collected from authors

Figure 3. The number of eligible articles by year of publication



Study Characteristics

Study characteristics are presented in Table 2. Across studies, the average recruitment rate was 37.46% and retention at the first follow-up was 71.72%. Follow-up duration ranged from 1 to 180 days, with an average of 73.58 days. The average eHealth treatment was 41.94 days (*Range* = 1 to 730 days). Most eHealth treatments were delivered via websites (k = 72), followed by telephone (k = 15) and a combination of website and telephone (k = 6). Regarding study design, most studies used inactive controls (k = 57) and employed an intention-to-treat analysis (k = 55).

Table 2. Study descriptives

Author	Treatment		Control Type	Recruitment Rate	Retention at Follow-Up	Follow-Up (days)	ITT Analysis
	Length (days)	Modality					
Agyapong et al., 2012	90	Text Messages	Inactive	42.2%	92.6%	90	Y
Andersson, 2015	7	Telephone + Website	Inactive	59.3%	84.8%	42	Y
Arnaud et al., 2016	1[a]	Website	Inactive	54.2%	14.6%	90	Y
Augsburger et al., 2022	56	Website	Active	67.0%	65.2%	180	Y
Barnett et al., 2007	30	CD-ROM	Active	59.0%	93.4.0%	90	-
Baumgartner et al., 2021	42	Website	Inactive	75.4%	21.4%	90	Y
Becker et al., 2014	1[a]	Website	Active	13.1%	26.2%	56	Y
Bertholet et al., 2015	1[a]	Website	Inactive	5.6%	90.5%	30	Y
Bewick et al., 2010	49	Website	Inactive[1]	86.9%	18.7%	56	-
Blankers et al., 2011	-	Website	Inactive	11.9%	59.5%	90	Y
Blow et al., 2017	90	Interactive Program Guided by Virtual Counselor	Active	17.1%	87.0%	90	N
Boß et al., 2018	35	Website	Inactive	51.8%	62.4%	42	Y
Bonar et al., 2022a	56	Telephone + Website/App	Inactive	8.5%	89.5%	90	Y
Bonar et al., 2022b	56	Website/App	Active	7.1%	84.2%	90	-
Bonar et al., 2023	56	Website/App	Active	15.0%	86.7%	90	-
Boyle et al., 2022	240[b]	Text Messages + Website	Active	54.8%	71.2%	60	-
Braitman et al., 2018	14	Website	Active	95.4%	26.1%	14	-
Brendryen et al., 2014	180	Text Messages + Website	Active	88.4%	31.6%	60	Y
Buckner et al., 2020	1[a]	Website	Inactive	-	61.8%	14	-
Butler et al., 2009	1	Slide Presentation on Computer	Active[1]	-	-	28	N
Cadigan et al., 2019	1[a]	Text Messages	Active	66.2%	97.0%	1	-
Chiauzzi et al., 2005	28	Website	Active	49.2%	80.0%	30	Y
Cunningham et al., 2009	1	Website	Inactive	2.2%	91.9%	90	Y
Cunningham et al., 2012	-	Website	Active	71.1%	90.0%	180	Y
Cunningham et al., 2021	-	Website	Inactive	16.7%	90.9%	90	Y
Deady et al., 2016	28	Website	Active	12.4%	38.5%	90	Y
Delrahim-Howlett et al., 2011	1[a]	Website	Active	10.0%	42.7%	30	-
Donovan et al., 2015	14	Website	Active	12.8%	76.4%	30	Y
Doumas et al., 2009	1	Website	Active	71.7%	88.2%	30	-
Doumas et al., 2011	1	Website	Active	91.8%	66.1%	30	-
Elliot et al., 2014	1	Website	Inactive	-	98.4%	30	Y
Freyer-Adam et al., 2018	90	-	Active[1]	15.4%	74.8%	180	-
Gajecki et al., 2014	49	App	Inactive	6.8%	70.5%	49	Y
Gajecki et al., 2017	42	App	Inactive[1]	72.4%	38.2%	42	-

Author	Length (days)	Modality	Control Type	Recruitment Rate	Retention at Follow-Up	Follow-Up (days)	ITT Analysis
Geisner et al., 2015	35	Website	Inactive	13.3%	91.9%	30	Y
Gex et al., 2023	28	App	Active	22.1%	83.3%	90	-
Goodness et al., 2020	90	Website	Inactive	7.0%	91.8%	90	N
Gryczynski et al., 2021	1	Interactive Computer Program	Active	30.7%	79.3%	90	Y
Hansen et al., 2012	1[a]	Website	Inactive	2.6%	77.0%	180	Y
Helzer et al., 2008	180	Telephone	Inactive	55.3%	80.8%	90	-
Hester et al., 2009	63	Website	Active	44.0%	86.3%	90	Y
Hester et al., 2012 – *Study 1*	1	Website	Inactive	72.7%	90.3%	30	-
Hester et al., 2012 – *Study 2*	1	Website	Inactive	78.9%	98.8%	30	-
Ingersoll et al., 2018	63	Website	Inactive	8.1%	90.1%	180	Y
Johansson et al., 2021a	84	Website	Inactive	83.1%	43.5%	90	Y
Johansson et al., 2021b	90	Website	Active	41.0%	57.1%	90	Y
Johnson et al., 2018	1	Website	Inactive	26.0%	75.9%	180	Y
Kypri et al., 2009	1	Website	Inactive	33.7%	64.8%	30	Y
Kypri et al., 2013	1	Website	Inactive	76.0%	79.0%	150	Y
Kypri et al., 2014	1	Website	Inactive	66.7%	83.3%	150	Y
LaBrie et al., 2013	-	Website	Inactive	38.0%	90.8%	30	-
Lee et al., 2010	90	Website	Inactive	16.1%	94.4%	90	Y
Lee et al., 2021	28	Text messages + Video-Conferencing	Inactive	18.9%	86.6%	30	Y
Leeman et al., 2016	1	Website	Inactive	50.6%	78.8%	30	Y
Lewis et al., 2014	-	Website	Inactive	3.3%	85.2%	90	Y
Liu et al., 2019	1	Website	Active	-	-	7	-
Mason et al., 2014	4	Text messages	Inactive	2.7%	100%	30	-
Mello et al., 2008	14	Telephone	Inactive	4.7%	95.8%	90	Y
Muench et al., 2017	84	Text messages	Active	13.7%	93.6%	N/A	Y
Murphy et al., 2010 – *Study 2*	1	Website	Inactive	12.1%	88.7%	30	N
Neighbors et al., 2004	1	Computer Program	Inactive	22.6%	82.1%	90	-
Neighbors et al., 2010	730	Website	Inactive	39.1%	81.3%	180	-
Olthof et al., 2023	28	App	Inactive	36.9%	75.1%	90	Y
Ondersma et al., 2007	1	Computer Program	Inactive	9.1%	77.6%	120	Y
Palfai et al., 2014	1[b]	Website	Active	11.4%	83.7%	90	-
Postel et al., 2010	90	Website	Inactive	92.3%	65.4%	N/A	Y
Riggs et al., 2018	-	Website	Active	32.5%	76.2%	42	-
Rooke et al., 2013	42	Website	Inactive	61.5%	54.2%	90	Y
Rose et al., 2017	1[a]	Telephone	Inactive	16.5%	73.5%	90	Y
Russell et al., 2022	30	Text Messages	Inactive	-	95.0%	30	-
Satre et al., 2019	-	Email	Active	39.0%	95%	180	-

Author	Length (days)	Modality	Motivational Interviewing	Control Type	Recruitment Rate	Retention at Follow-Up	Follow-Up (days)	ITT Analysis
Schaub et al., 2015	42	Website		Inactive	70.6%	38.0%	90	Y
Schaub et al., 2019	42	Website		Inactive	74.8%	15.1%	180	N
Schluter et al., 2022	1	Audio-only Conferencing		Inactive	24.0%	74.8%	90	Y
Sinadinovic et al., 2020	42	Website		Inactive	35.5%	40.9%	90	Y
Steers et al., 2016	1[a]	Website		Inactive	-	93.8%	14	-
Strickland et al., 2019	14	Website		Inactive	21.9%	69.6%	14	-
Suffoletto et al., 2012	84	Text Messages		Active[1]	41.2%	86.7%	90	-
Suffoletto et al., 2015	84	Text Messages		Inactive	25.0%	56.9%	90	Y
Sundström et al., 2020	84	Text Messages + Website		Inactive	32.8%	66.9%	84	Y
Teeters et al., 2018	1[a]	Text Messages + Website		Active	16.8%	90.5%	90	Y
Tello et al., 2018	1[a]	Computer Program		Inactive	-	-	14	-
Tensil et al., 2013	14	Website		Active	5.5%	49.6%	42	Y
Tossmann et al., 2011	50	Website		Inactive	100%	15.9%	90	Y
Van Dessel et al., 2023 – *Study 1*	7	Website		Active	63.6%	83.5%	7	Y
Van Dessel et al., 2023 – *Study 2*	7	Website		Active	84.9%	74.6%	7	Y
Voogt et al., 2013a	1	Website		Inactive	44.3%	45.9%	30	Y
Voogt et al., 2013b	1	Website		Inactive	18.3%	90.7%	30	Y
Voogt et al., 2014	1	Website		Inactive	18.3%	81.6%	30	Y
Wagener et al., 2012	1	Computer Program		Active[1]	12.0%	94.7%	70	-
Wallace et al., 2011	-	Website		Active	78.2%	10.8%	90	-
Walton et al., 2013	1[a]	Interactive Computer Program		Active[1]	23.1%	83.8%	90	-
Wirtz et al., 2022	28	Website		Inactive	-	-	28	Y
Witkiewitz et al., 2014	14	App		Inactive	40.3%	89.4%	30	Y
Young et al., 2019	1	Website		Active	72.1%	67.6%	30	-

- = Not Reported / Unclear; Y = Yes

[1]Combined control groups

[a]Assumed to be 1 day based on the treatment description.

[b]Came from data outside of the manuscript.

Treatment Components

Based on bottom-up coding (Braun & Clarke, 2006), thirteen treatment components were identified across the included studies (see Table 3 for definitions and Appendix E for a study-by-study overview). The most used treatment components were harm reduction (100%), personalized feedback (95.7%), and psychoeducation (95.7%). Other frequently used components were cognitive strategies (82.8%), behavioral strategies (73.1%), behavioral modification (72.0%), goal setting and action planning (63.4%), relapse prevention (62.4%), self-monitoring (60.2%), and motivational interviewing (58.1%). Less commonly used components were emotional regulation and mental health support (34.4%), operant conditioning (32.3%), and peer and interpersonal support (11.8%).

Table 3. Treatment component definitions

Treatment Component	Definition
Personalized Feedback	Providing individualized insights based on a person's substance use patterns, health risks, and social comparisons to encourage self-awareness and behavior change. *Examples* include personalized normative feedback, personalized risk assessment, feedback on health consequences, blood alcohol concentration estimation, alcohol/cannabis-related problem feedback, and graphical/interactive feedback.
Self-Monitoring	Encouraging individuals to track their substance use and related behaviors to increase self-awareness and facilitate behavior change. *Examples* include tracking substance use, mood and emotional tracking, self-monitoring of triggers and cravings, and monitoring progress toward goals.
Motivational Interviewing	Strengthening an individual's internal motivation to change by addressing ambivalence and reinforcing personal reasons for reducing or quitting substance use. *Examples* include motivational interviewing techniques
Goal Setting & Action Planning	Helping individuals set and achieve specific, measurable, and attainable goals for reducing and/or quitting substance use. *Examples* include goal settings and progress tracking, and action planning.
Psychoeducation	Providing factual information about alcohol and cannabis use to enhance awareness of risk, health effects, and harm reduction strategies. *Examples* include general education on substance use, harm reduction strategies, health-related information, legal/social implications, and social norm corrections.
Cognitive Strategies	Thought-based techniques aimed at changing maladaptive beliefs, perceptions, and cognitive patterns related to substance use. *Examples* include cognitive restructuring, decisional balance exercises, self-efficacy enhancement, and mindfulness techniques that promote cognitive awareness.
Behavioral Strategies	Action-based techniques that focus on modifying behaviors to reduce and/or quit substance use. *Examples* include protective behavioral strategies, behavioral activation, problem-solving training, and managing high-risk situations.

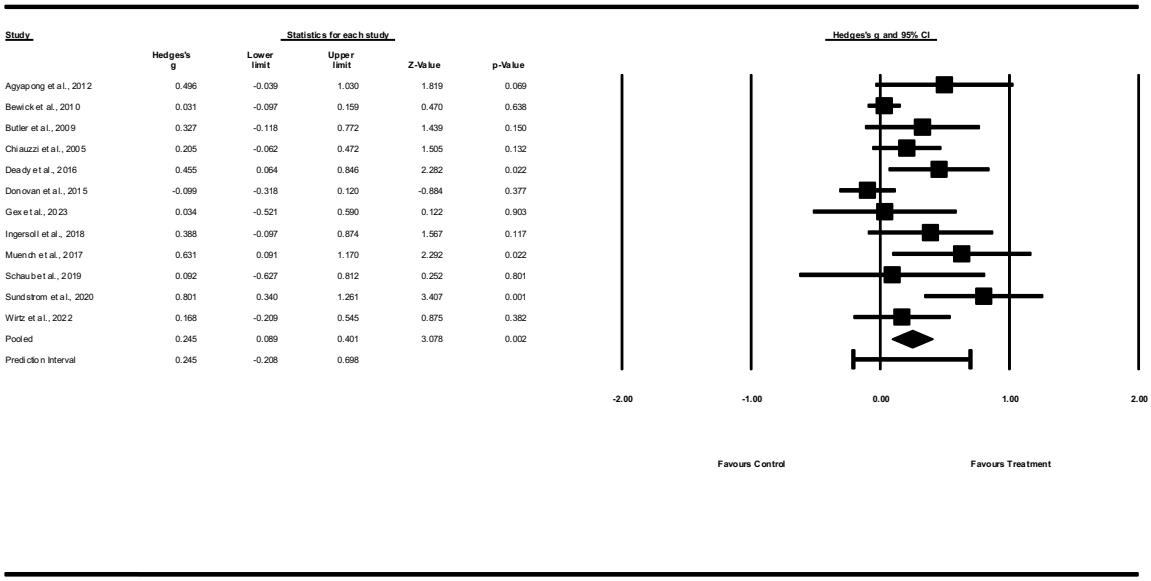
Behavioral Modification	Encouraging individuals to develop healthier behaviors, replace substance use with positive alternatives and build resilience through lifestyle change. *Examples* include developing healthy coping strategies, encouraging alternative activities, building self-efficacy, reinforcing positive behavior changes, strengthening decision-making skills, improving impulse control, and addressing environmental cues.
Emotional Regulation & Mental Health Support	Addressing emotional distress, negative thought patterns, and co-occurring mental health concerns to support substance use reduction. *Examples* include managing co-occurring mental health symptoms, mindfulness and stress reduction techniques, cognitive reframing for emotional regulation, behavioral activation for mood improvement, and identifying and managing emotional triggers.
Peer and Interpersonal Support	Support for close social connections, such as friends, family, and peers, to reinforce behavior change. *Examples* include building a support network, strengthening relationships, and encouraging social connectedness.
Harm Reduction	Strategies aimed at minimizing the negative effects of substance use without necessarily requiring abstinence. *Examples* include minimizing risks of use, protective behavioral strategies, encouraging alternative activities, and addressing polysubstance use risk.
Relapse Prevention	Strategies designed to help individuals maintain progress and prevent setbacks after reducing or quitting substance use. *Examples* include identifying high-risk situations, developing coping strategies, dealing with slips and lapses, and building long-term resilience.
Operant Conditioning	Modification of behavior through reinforcement (positive or negative), punishment, or contingency management to increase or decrease specific substance use behaviors. *Examples* include financial incentives, vouchers, social rewards, reducing treatment requirements for continued abstinence, loss of privileges for substance use, and earning points for drug-free urine tests.

Alcohol Use

Post-Treatment

Twelve studies were analyzed, and no outliers were identified. The effect of the treatment versus control group on alcohol use outcomes at post-treatment was small but significant (g = .25; 95% CI [.09, .40]; Z = 3.08, p = .002; Figure 4). The Q-value was 24.71 (p = .01), suggesting treatments were more effective in some studies compared to others, highlighting the importance of moderation analyses. Heterogeneity was moderate to substantial, suggesting 55.5% of the observed effects reflect variance in the true effect rather than sampling error. The prediction interval ranged from -0.21 to 0.70. Evidence of publication bias was found (Egger's test p = .01). After trimming five studies, the effect was no longer significant (g = .07, 95% CI [-.09, .24], Q = 51.43; Appendix Figure F1).

Figure 4. eHealth program effects on alcohol use outcomes at post-treatment



Study	Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
Agyapong et al., 2012	0.496	-0.039	1.030	1.819	0.069
Bewick et al., 2010	0.031	-0.097	0.159	0.470	0.638
Butler et al., 2009	0.327	-0.118	0.772	1.439	0.150
Chiauzzi et al., 2005	0.205	-0.062	0.472	1.505	0.132
Deady et al., 2016	0.455	0.064	0.846	2.282	0.022
Donovan et al., 2015	-0.099	-0.318	0.120	-0.884	0.377
Gex et al., 2023	0.034	-0.521	0.590	0.122	0.903
Ingersoll et al., 2018	0.388	-0.097	0.874	1.567	0.117
Muench et al., 2017	0.631	0.091	1.170	2.292	0.022
Schaub et al., 2019	0.092	-0.627	0.812	0.252	0.801
Sundstrom et al., 2020	0.801	0.340	1.261	3.407	0.001
Wirtz et al., 2022	0.168	-0.209	0.545	0.875	0.382
Pooled	0.245	0.089	0.401	3.078	0.002
Prediction Interval	0.245	-0.208	0.698		

Subgroup Analysis. At post-treatment, eHealth treatments targeting alcohol use reported larger effects for the following subgroups: 1) studies with an ARSU inclusion requirement (g = .57, 95% CI [.30, .85]) versus those that did not (g = .11, 95% CI [-.01, .23], p = .002) and 2) studies with non-college/university participants (g = .44, 95% CI [.26, .62]) versus those with (g = .05, 95% CI [-.06, .15], p < .001; Appendix Tables G1-G2). Effect size did not differ based on treatment modality (p = .39), control type (p = .69), intention-to-treat analysis (p = .76), or continent of publication (p = .57).

Meta-Regression. At post-treatment, sample mean age (in years) was positively associated with the effect size of alcohol use outcomes (β = .02, 95% CI [.001, .032], p = .01; Appendix Figure G1). No significant associations were found between effect size and the following: publication year (p = .58), treatment length (p = .05), follow-up duration (p = .35), percentage of females/women in the sample (p = .61), and percentage of White/Caucasian participants in the sample (p = .83). The percentage of participants who were married or in a relationship could not be analyzed due to an insufficient number of studies reporting this variable (k = 3).

Treatment Components. At post-treatment, eHealth treatments that included a relapse prevention component reported larger effects (g = .46, 95% CI [.26, .65]) versus those that did not (g = .06, 95% CI [-.01, .17], p = .001; see Table 4 for a summary of treatment component results; Appendix Table G3). No significant differences in effect size were identified based on the inclusion of personalized feedback (p = .72), self-monitoring (p = .51), motivational interviewing (p = .91), goal setting and action planning (p = .67), cognitive strategies (p = .43), behavioral strategies (p = .61), behavioral modification (p = .61), emotional regulation and

mental health support (p = .99), or peer and interpersonal support (p = .70). Psychoeducation and harm reduction components were not examined, as all studies included these components.

Table 4. Summary of moderation analyses findings

Substance	Timepoint	College/ University Sample	At-Risk Substance Use	% White/ Caucasian	% Female/ Woman	% in Relationship/ Married	Sample Mean Age
		Participant-Level					
Alcohol Use	*Post-Treatment*	✓	✓	-	-	-	✓
	Follow-Up	-	-	-	-	-	-
Cannabis Use	*Follow-Up*	-	-	-	-	-	-

Substance	Timepoint	Treatment Length	Treatment Modality	Follow-Up Duration	Intention-to-Treat Analysis	Continent of Publication
		Treatment-Level				
Alcohol Use	*Post-Treatment*	-	-	-	-	-
	Follow-Up	-	-	-	✓	-
Cannabis Use	*Follow-Up*	-	-	-	-	✓

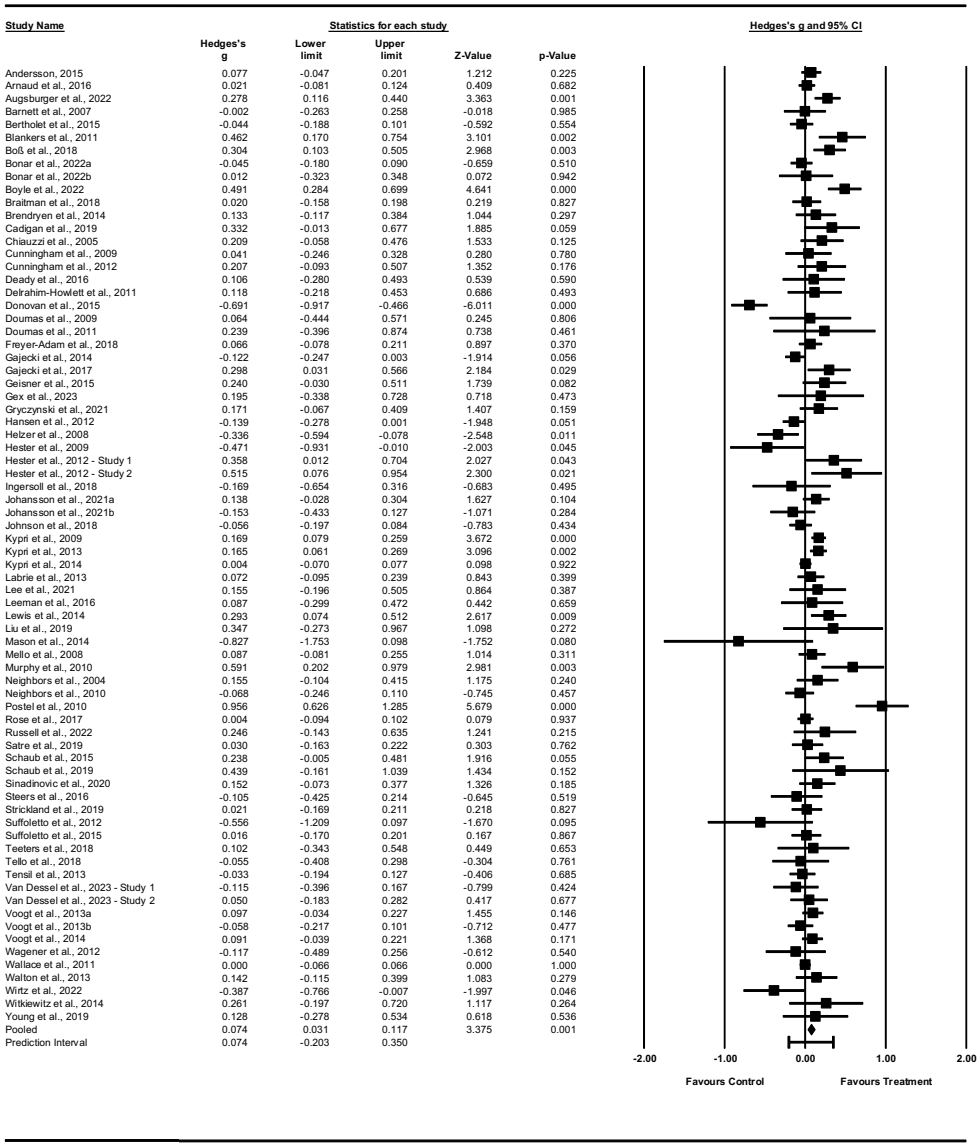
Substance	Timepoint	Control Type	Year of Publication
		Study-Level	
Alcohol Use	*Post-Treatment*	-	-
	Follow-Up	-	-
Cannabis Use	*Follow-Up*	-	-

Substance	Timepoint	Personalized Feedback	Self-Monitoring	Motivational Interviewing	Goal Setting & Action Planning	Psycho-education	Cognitive Strategies	Behavioral Strategies	Behavioral Modification	Emotional Regulation & Mental Health Support	Harm Reduction	Relapse Prevention	Operant Conditioning
		Treatment Components											
Alcohol Use	*Post-Treatment*	-	-	-	-	-	-	-	-	-	-	✓	-
	Follow-Up	-	-	✓	-	-	✓	-	-	✓	-	✓	-
Cannabis Use	*Follow-Up*	-	-	-	-	-	-	-	-	-	-	-	-

Follow-Up

Seventy-four studies were analyzed, and no outliers were identified. The effect of treatment versus control on alcohol use outcomes at the first follow-up was minimal but significant (g = .07; 95% CI [.03, .12]; Z = 3.38, p = .001; Figure 5). The Q-value was 225.43 (p < .001), highlighting the importance of moderation analyses. I^2 suggested moderate to substantial heterogeneity, with 67.62% of the observed effects reflecting variance in the true effect rather than sampling error. The prediction interval suggested the true effect size of 95% of all comparable populations falls between the interval of -.20 and .35. Publication bias was unlikely, as indicated by Egger's test (p = .09). However, when 11 studies were trimmed, the effect was no longer significant (g = .03, 95% CI [-.02, .07], Q = 319.81; Appendix Figure F2).

Figure 5. eHealth program effects on alcohol use outcomes at follow-up



Study Name	Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
Andersson, 2015	0.077	-0.047	0.201	1.212	0.225
Arnaud et al., 2016	0.021	-0.081	0.124	0.409	0.682
Augsburger et al., 2022	0.278	0.116	0.440	3.363	0.001
Barnett et al., 2007	-0.002	-0.263	0.258	-0.018	0.985
Bertholet et al., 2015	-0.044	-0.188	0.101	-0.592	0.554
Blankers et al., 2011	0.462	0.170	0.754	3.101	0.002
Boß et al., 2018	0.304	0.103	0.505	2.968	0.003
Bonar et al., 2022a	-0.045	-0.180	0.090	-0.659	0.510
Bonar et al., 2022b	0.012	-0.323	0.348	0.072	0.942
Boyle et al., 2022	0.491	0.284	0.699	4.641	0.000
Braitman et al., 2018	0.020	-0.158	0.198	0.219	0.827
Brendryen et al., 2014	0.133	-0.117	0.384	1.044	0.297
Cadigan et al., 2019	0.332	-0.013	0.677	1.885	0.059
Chiauzzi et al., 2005	0.209	-0.058	0.476	1.533	0.125
Cunningham et al., 2009	0.041	-0.246	0.328	0.280	0.780
Cunningham et al., 2012	0.207	-0.093	0.507	1.352	0.176
Deady et al., 2016	0.106	-0.280	0.493	0.539	0.590
Delrahim-Howlett et al., 2011	0.118	-0.218	0.453	0.686	0.493
Donovan et al., 2015	-0.691	-0.917	-0.466	-6.011	0.000
Doumas et al., 2009	0.064	-0.444	0.571	0.245	0.806
Doumas et al., 2011	0.239	-0.396	0.874	0.738	0.461
Freyer-Adam et al., 2018	0.066	-0.078	0.211	0.897	0.370
Gajecki et al., 2014	-0.122	-0.247	0.003	-1.914	0.056
Gajecki et al., 2017	0.298	0.031	0.566	2.184	0.029
Geisner et al., 2015	0.240	-0.030	0.511	1.739	0.082
Gex et al., 2023	0.195	-0.338	0.728	0.718	0.473
Gryczynski et al., 2021	0.171	-0.067	0.409	1.407	0.159
Hansen et al., 2012	-0.139	-0.278	0.001	-1.948	0.051
Helzer et al., 2008	-0.336	-0.594	-0.078	-2.548	0.011
Hester et al., 2009	-0.471	-0.931	-0.010	-2.003	0.045
Hester et al., 2012 - Study 1	0.358	0.012	0.704	2.027	0.043
Hester et al., 2012 - Study 2	0.515	0.076	0.954	2.300	0.021
Ingersoll et al., 2018	-0.169	-0.654	0.316	-0.683	0.495
Johansson et al., 2021a	0.138	-0.028	0.304	1.627	0.104
Johansson et al., 2021b	-0.153	-0.433	0.127	-1.071	0.284
Johnson et al., 2018	-0.056	-0.197	0.084	-0.783	0.434
Kypri et al., 2009	0.169	0.079	0.259	3.672	0.000
Kypri et al., 2013	0.165	0.061	0.269	3.096	0.002
Kypri et al., 2014	0.004	-0.070	0.077	0.098	0.922
Labrie et al., 2013	0.072	-0.095	0.239	0.843	0.399
Lee et al., 2021	0.155	-0.196	0.505	0.864	0.387
Leeman et al., 2016	0.087	-0.299	0.472	0.442	0.659
Lewis et al., 2014	0.293	0.074	0.512	2.617	0.009
Liu et al., 2019	0.347	-0.273	0.967	1.098	0.272
Mason et al., 2014	-0.827	-1.753	0.098	-1.752	0.080
Mello et al., 2008	0.087	-0.081	0.255	1.014	0.311
Murphy et al., 2010	0.591	0.202	0.979	2.981	0.003
Neighbors et al., 2004	0.155	-0.104	0.415	1.175	0.240
Neighbors et al., 2010	-0.068	-0.246	0.110	-0.745	0.457
Postel et al., 2010	0.956	0.626	1.285	5.679	0.000
Rose et al., 2017	0.004	-0.094	0.102	0.079	0.937
Russell et al., 2022	0.246	-0.143	0.635	1.241	0.215
Satre et al., 2019	0.030	-0.163	0.222	0.303	0.762
Schaub et al., 2015	0.238	-0.005	0.481	1.916	0.055
Schaub et al., 2019	0.439	-0.161	1.039	1.434	0.152
Sinadinovic et al., 2020	0.152	-0.073	0.377	1.326	0.185
Steers et al., 2016	-0.105	-0.425	0.214	-0.645	0.519
Strickland et al., 2019	0.021	-0.169	0.211	0.218	0.827
Suffoletto et al., 2012	-0.556	-1.209	0.097	-1.670	0.095
Suffoletto et al., 2015	0.016	-0.170	0.201	0.167	0.867
Teeters et al., 2018	0.102	-0.343	0.548	0.449	0.653
Tello et al., 2018	-0.055	-0.408	0.298	-0.304	0.761
Tensil et al., 2013	-0.033	-0.194	0.127	-0.406	0.685
Van Dessel et al., 2023 - Study 1	-0.115	-0.396	0.167	-0.799	0.424
Van Dessel et al., 2023 - Study 2	0.050	-0.183	0.282	0.417	0.677
Voogt et al., 2013a	0.097	-0.034	0.227	1.455	0.146
Voogt et al., 2013b	-0.058	-0.217	0.101	-0.712	0.477
Voogt et al., 2014	0.091	-0.039	0.221	1.368	0.171
Wagener et al., 2012	-0.117	-0.489	0.256	-0.612	0.540
Wallace et al., 2011	0.000	-0.066	0.066	0.000	1.000
Walton et al., 2013	0.142	-0.115	0.399	1.083	0.279
Wirtz et al., 2022	-0.387	-0.766	-0.007	-1.997	0.046
Witkiewitz et al., 2014	0.261	-0.197	0.720	1.117	0.264
Young et al., 2019	0.128	-0.278	0.534	0.618	0.536
Pooled	0.074	0.031	0.117	3.375	0.001
Prediction Interval	0.074	-0.203	0.350		

Subgroup Analysis. At follow-up, studies that did not employ an intention-to-treat analysis (g = .54, 95% CI [.15, .93]) had larger effects than those that did (g = .06, 95% CI [.01, .12], p = .02; Appendix Table H1). No significant differences in effect sizes were found based on control type (p = .41), ARSU inclusion requirement (p = .20), college/university sample (p = .61), continent of publication (p = .69), or treatment modality (p = .44).

Meta-Regression. At follow-up, the effect size of eHealth treatments on alcohol use outcomes did not differ based on publication year (p = .98), treatment length (p = .89), follow-up duration (p = .71), sample mean age (p = .96), percentage of females/women in the sample (p = .70), percentage of participants married/in a relationship in the sample (p = .33), or percentage of White/Caucasian participants in the sample (p = .13).

Treatment Components. At follow-up, eHealth treatments reported larger effect sizes when the following treatment components were included: 1) motivational interviewing (g = .13, 95% CI [.06, .19]) versus those without (g = .03, 95% CI [-.03, .09], p = .02); 2) cognitive strategies (g = .10, 95% CI [.05, .15]) versus those without (g = -.05, 95% CI [-.16, .05], p = .01); 3) emotional regulation and mental health support (g = .14, 95% CI [.06, .22]) versus those without (g = .05, 95% CI [-.01, .10]; p = .048); and 4) relapse prevention (g = .12, 95% CI [.06, .17]) versus those without (g = .01, 95% CI [-.06, .08]; p = .01; Table 4; Appendix Tables H2-H5). There were no significant differences in effect sizes based on the presence or absence of personalized feedback (p = .13), self-monitoring (p = .96), goal setting and action planning (p = .61), psychoeducation (p = .22), behavioral strategies (p = .36), behavioral modification (p = .70), peer and interpersonal support (p = .44), or operant conditioning (p = .37). Harm reduction could not be examined as it was included in all studies, resulting in insufficient variability.

Cannabis Use

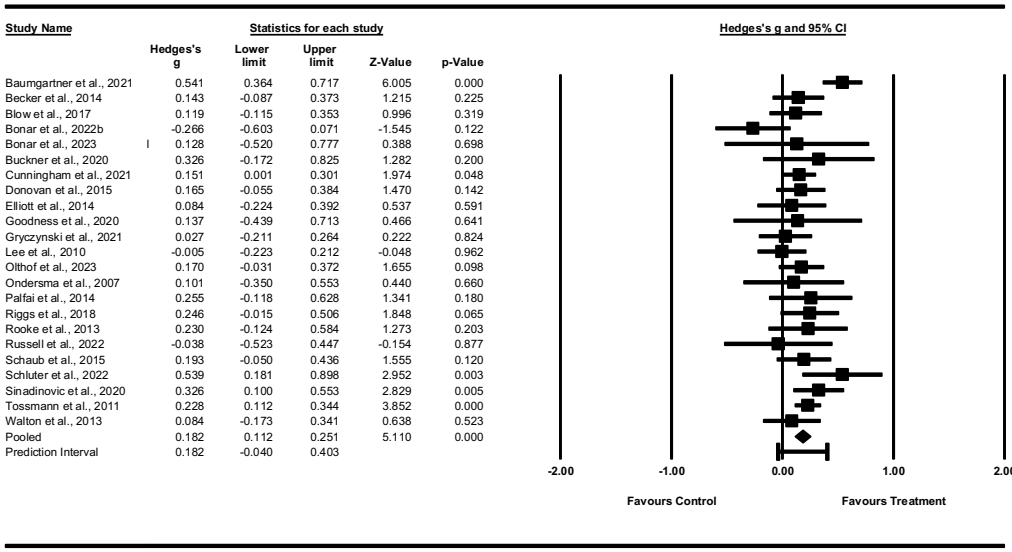
Post-Treatment

Only three studies reported post-treatment cannabis use outcomes; therefore, a meta-analysis could not be conducted due to insufficient data (Myung, 2023).

Follow-Up

Twenty-three studies were analyzed, and no outliers were identified. The effect of treatment versus control on cannabis use outcomes at follow-up was small (g = .18; 95% CI [.11, .25]; Z = 5.11, p < .001; Figure 6). The Q-value is 36.22 (p = .03), highlighting the importance of moderation analyses. I^2 suggested heterogeneity may not be important to moderate heterogeneity, with 39.26% of the observed effects reflecting variance in the true effect rather than sampling error. The prediction interval suggested the true effect size of 95% of all comparable populations falls between the interval of -.04 and .40. Publication bias was unlikely, as indicated by Egger's test (p = .18) and the trim-and-fill procedure suggested no studies were missing or trimmed (Appendix Figure F3).

Figure 6. eHealth program effects on cannabis use outcomes at follow-up



Subgroup Analysis. At follow-up, the effect size was larger for studies that were published outside of North America (g = .27, 95% CI [.18, .37]) compared to those conducted within North America (g = .12, 95% CI [.04, .20]; p = .02; Appendix Table I1). No significant differences in effect sizes were observed based on treatment modality (p = .64), control type (p = .08), intention-to-treat analysis (p = .56), college/university sample (p = .60), or ARSU inclusion criteria (p = .65).

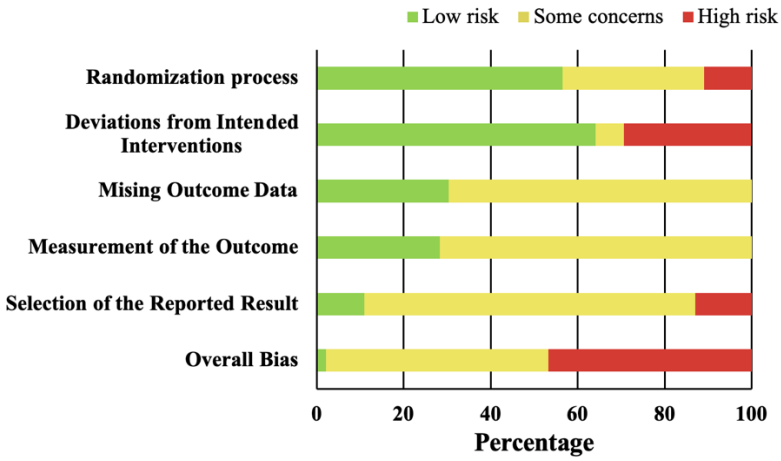
Meta-Regression. At follow-up, no significant associations were found between effect size and publication year (p = .51), treatment length (p = .85), follow-up duration (p = .54), sample mean age (p = .08), percentage of females/women (p = .14), percentage of participants married/in a relationship in the sample (p = .53), or percentage of White/Caucasian participants in the sample (p = .08).

Treatment Components. At follow-up, there were no significant differences in effect size based on the presence or absence of self-monitoring (p = .06), motivational interviewing (p = .80), goal setting and action planning (p = .21), cognitive strategies (p = .61), behavioral strategies (p = .59), behavioral modification (p = .61), emotional regulation and mental health support (p = .14), peer and interpersonal support (p = .22), relapse prevention (p = .31), or operant conditioning (p = .75; Table 4). Personalized feedback, psychoeducation, and harm reduction could not be examined due to insufficient variability, as all studies included these components.

Risk of Bias Assessment

The Cochrane Collaboration's Risk of Bias Tool (Higgins et al., 2024) identified most studies as having some concerns of bias (k = 47; 50.5%), followed by high risk of bias (k = 44; 47.3%) and low risk of bias (k = 2; 2.2%; Figure 7; Appendix J).

Figure 7. Summary of results from the Cochrane Collaboration's Risk of Bias Tool (Higgins et al., 2024)



Discussion

This meta-analysis builds on a growing body of research examining the effectiveness of eHealth treatments on alcohol and cannabis use by synthesizing findings across 93 RCTs and identifying moderators that impact treatment effects. Small, but significant, reductions in alcohol (at post-treatment) and cannabis use (at follow-up) were observed; cannabis use could not be examined at post-treatment due to an insufficient number of studies. Treatment effects for alcohol use were strongest at post-treatment and diminished at follow-up. Findings highlight the promise of eHealth as a scalable and low-barrier treatment option, while also highlighting the challenges in sustaining treatment gains over time for alcohol use. Moderate to substantial heterogeneity suggested meaningful variability in treatment effects across studies, prompting an examination of moderators including participant-, treatment-, and study-level factors, as well as treatment components. Several significant moderators and treatment components were identified. Results emphasize the need for more high-quality RCTs focused on cannabis use outcomes and

support the development of tailored eHealth treatments that incorporate evidence-based components, and address unmet needs identified through moderation analyses.

Alcohol Use

While eHealth treatments showed small effects on alcohol use at post-treatment (g = .25), this effect was minimal at follow-up (g = .07), raising concerns about sustaining treatment effects long-term. One of the primary challenges of alcohol use treatment is the high risk of relapse, with at least 60% of individuals with an alcohol use disorder relapsing to hazardous drinking within six months after treatment (Durazzo & Meyerhoff, 2017; Kirshenbaum et al., 2009; Maisto et al., 2006). Findings align with Marlatt's Model of Relapse which highlights the importance of ongoing reinforcement, coping strategies, and self-efficacy to maintain behavior change (Larimer et al., 2003), all of which may be required to maintain treatment gains long-term. Despite this, the observed short-term effects of eHealth treatments are of clinical value as a first-line treatment for alcohol use or for individuals who face barriers to accessing traditional in-person treatments. Since eHealth treatments are low-cost and scalable (Puleo et al., 2021), integrating booster sessions, peer support, and relapse prevention components may also be feasible methods to maintain treatment gains and reduce relapse risk.

Substantial heterogeneity was observed at both alcohol use assessment points, suggesting that treatment effects varied across studies and highlighting the importance of conducting moderator analyses. At post-treatment, larger effects were observed among studies with non-college/university samples, an older sample mean age, and an ARSU requirement. Extant research suggests that college/university students often overestimate peer drinking behavior and approval which is associated with heavier drinking, lower perceived risk, and reduced motivation to change (Borsari & Carey, 2003; Cox et al., 2019). As such, students may be less likely to view

their alcohol use as problematic or to engage meaningfully with eHealth treatments, resulting in smaller observed treatment effects compared to their non-student counterparts. In contrast, older adults may experience more immediate or severe health consequences related to prolonged alcohol use (e.g., hypertension, liver disease), which may increase perceived risk (Åberg et al., 2023; Fuchs & Fuchs, 2021). According to the Transtheoretical Model of Behavior Change (del Rio Szupszynski & de Ávila, 2021), higher perceived risk can enhance motivation and readiness to change, potentially improving treatment engagement and eHealth treatment outcomes among this group. Studies with an ARSU inclusion requirement also reported larger treatment effects at post-treatment. These findings may be attributed to elevated distress/impairment which enhances perceived risk and motivation for change (del Rio Szupszynski & de Ávila, 2021) and eHealth treatments often target specific behaviors, beliefs, and risks that are of greater relevance to those with ARSU. Finally, studies that did not use an intention-to-treat analysis reported larger effects at follow-up, likely due to differential dropout and limiting analyses to participants who were more engaged, which inflates treatment effect estimates (McCoy, 2017). The remaining moderators were not associated with treatment effects, which may reflect insufficient variability across studies, measurement inconsistencies, lack of statistical power, possible indirect/mediated effects, or a true lack of moderating effects. Together, these findings underscore the importance of specific moderators in eHealth treatment effectiveness.

Several treatment components were associated with improved alcohol use outcomes, including relapse prevention (at post-treatment and follow-up), motivational interviewing (at follow-up), cognitive strategies (at follow-up), and emotional regulation and mental health support (at follow-up). These components may be particularly effective because they improve an individual's capacity to manage internal experiences such as cravings, maladaptive thoughts, and

emotional distress, factors known to impact alcohol use (Larimer et al., 2003; Sinha, 2012; Stohs et al., 2019). Motivational interviewing has similarly been shown to enhance autonomy, resolve ambivalence, and foster self-efficacy, which is crucial for sustaining behavior change (Miller & Rose, 2009). This contrasts with other identified treatment components, like psychoeducation and goal setting/action planning, which primarily deliver information or promote structured behavioral tasks which may not address the psychological mechanisms underlying substance use (Larimer et al., 2003; Magill et al., 2022; Maurage et al., 2024). Treatment components that rely more heavily on an individual's motivation (e.g., psychoeducation) may also be less effective in the absence of motivational interviewing or cognitive/emotional strategies (Menon & Kandasamy, 2018), as their success depends on the individual's ability to translate knowledge into action. While these components may enhance self-awareness or provide structure, their impact may be limited in the absence of strategies that regulate emotion or challenge maladaptive thoughts, both of which are important to sustained recovery (Witkiewitz & Marlatt, 2004). Collectively, findings highlight the importance of integrating relapse prevention, cognitive strategies, motivational interviewing, and emotional regulation and mental health support into eHealth treatments to reduce alcohol use.

Cannabis Use

This review identified notable gaps in existing literature regarding short-term cannabis use outcomes, with only three studies reporting post-treatment data, thereby preventing a meta-analysis at this timepoint. This broader scarcity of cannabis-specific studies, relative to alcohol-specific ones, may reflect the historical underrepresentation of cannabis in clinical research, potentially due to cross-country differences in legalization status or publication bias (Devito & Goldacre, 2019; Ransing et al., 2022). At follow-up, eHealth treatment showed small but

significant effects in reducing cannabis use (g = .18). Heterogeneity at follow-up was low to moderate, suggesting greater consistency in treatment effects compared to alcohol use outcomes. This consistency in treatment effects may be attributed to methodological similarities across cannabis trials, including similar outcome measures, sample demographics, or treatment design. These findings highlight the potential of eHealth treatments in reducing cannabis use and the need for further research at earlier timepoints (e.g., post-treatment).

Although heterogeneity was relatively low, moderation analyses suggested continent of publication contributed to variations in treatment effects at follow-up. Specifically, studies conducted outside of North America reported larger effects compared to those conducted within North America. These differences may reflect variation in public health infrastructure, cultural attitudes toward cannabis use, or the integration of eHealth into healthcare systems (da Fonseca et al., 2021; Rafei et al., 2023). All other participant-, treatment-, and study-level moderators (e.g., treatment length, control type) were not significantly associated with treatment effects. These findings suggest consistency in treatment effects across most moderators, as evidenced by low heterogeneity. Similarly, no treatment components were associated with cannabis use outcomes at follow-up. This may reflect the limited number of studies on cannabis, reduced variability in the treatment components used across studies, or insufficient power to detect small effects. Many treatments also included overlapping components which may make it difficult to isolate the unique contribution of any single treatment component. It is also possible that the mechanisms underlying change in cannabis use may differ from alcohol use (e.g., different motivations for use, perceived risks associated with method of use), and the components assessed here may not have captured the cannabis use change process (Florimbio et al., 2023; Simons et al., 1998). Taken together, these findings highlight the need for more nuanced eHealth

research on cannabis use outcomes that can disentangle mechanisms of change and further inform the development of evidence-based eHealth treatments.

Strengths and Limitations

Results should be interpreted with several limitations and strengths in mind. First, a meta-analysis of post-treatment cannabis use outcomes could not be conducted due to an insufficient number of studies. Several subgroup and meta-regression analyses similarly could not be conducted due to insufficient variability across studies. Considerable variability in the measurement and reporting of alcohol and cannabis use outcomes (quantity and frequency) was also identified, which may have impacted treatment effects and limits generalizability to specific user profiles (see Appendix B). Findings may also not generalize to other substances beyond alcohol and cannabis. Although publication bias was identified at post-treatment for alcohol use outcomes, its clinical utility is limited given the high degree of heterogeneity, which reduces the reliability of tests for publication bias. Finally, the Cochrane Collaboration's Risk of Bias Tool (Higgins et al., 2024) also suggested that most studies had a high risk or some concerns of bias, with only 2.2% of studies demonstrating a low risk of bias. Common issues identified in this assessment included lack of assessor blinding, missing data, and unclear allocation concealment.

Despite these limitations, this meta-analysis has several notable strengths. To our knowledge, this is the first meta-analysis to simultaneously evaluate the effectiveness of eHealth treatments on alcohol and cannabis use outcomes. It provides a comprehensive and well-powered examination of eHealth treatments by synthesizing data from 93 RCTs with 51,833 participants. Rigorous methodological standards were also employed including PROSPERO registration, adherence to PRISMA guidelines (Moher et al., 2009), and use of the Cochrane Collaboration's Risk of Bias Tool (Higgins et al., 2024). Finally, this meta-analysis incorporated moderator

analyses across participant-, treatment-, and study-level variables, as well as 13 treatment components. Although broadening our inclusion criteria enhanced power and generalizability, this limits our ability to draw conclusions about specific populations who remain understudied, such as mothers of young children. Despite this, the inclusion of moderators strengthens the practical relevance of this meta-analysis and its implications for future eHealth treatment design.

Implications and Future Directions

This review identifies gaps in our knowledge and outlines priorities for clinical application and future research on eHealth treatment for alcohol and cannabis use. eHealth treatments offer a scalable, low-cost option to reduce alcohol and cannabis use and may be useful as early treatments or adjuncts to traditional in-person substance use treatment (Puleo et al., 2021). Development of future eHealth treatments for alcohol use should prioritize the inclusion of relapse prevention, cognitive strategies, motivational interviewing, and emotional regulation and mental health supports. Tailored eHealth treatment approaches may be warranted as findings suggest current eHealth treatments are more effective for older adults, individuals with ARSU, and non-college/university samples compared to their counterparts. Despite these promising results, eHealth treatments should not be viewed as a replacement for traditional treatment for individuals with severe alcohol and/or cannabis use disorders who may require more intensive and interdisciplinary treatments (e.g., medical monitoring, medication-assisted treatment; Bahji et al., 2022; Connor et al., 2022; Pribék et al., 2021). Instead, eHealth treatments may be best positioned as first-line, bridging, or maintenance options within stepped-care models (O'Donohue & Draper, 2011).

From a research standpoint, there is a need for more high-quality RCTs on cannabis use, particularly those that include post-treatment data, to better understand short- and long-term

treatment effects. Null findings for all eHealth treatment components in cannabis use research also suggests a need to systematically examine mechanisms of change and determine whether they differ from those underlying alcohol use. Future research should also prioritize the use of standardized outcome measures, such as the Alcohol Use Disorder Identification Test, Cannabis Use Disorder Identification Test – Revised, and the Timeline Follow Back (Adamson & Sellman, 2003*;* Babor et al., 2001; Robinson et al., 2014; Sobell & Sobell, 1992). Finally, future research should increase transparency in reporting (e.g., publishing protocols), improve methodological rigor using intention-to-treat analyses, and expand moderator analyses to enhance interpretability and clinical utility of future findings.

Conclusions

Findings from this meta-analysis support the effectiveness of eHealth treatments in reducing alcohol at post-treatment and cannabis use at follow-up. While effects were modest, results offer evidence for the clinical utility of eHealth treatments as a cost-effective, low-barrier, and scalable treatment to support reductions in alcohol and cannabis use. By identifying key moderators and treatment components, this review advances our knowledge of how, for whom, and under what conditions eHealth treatments are most effective. Insights from this review can inform eHealth treatment development to enhance reach and sustain impacts in diverse populations who use alcohol and cannabis.

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CHAPTER THREE: Transitional Chapter

Extending eHealth Research to Underserved Maternal Populations

The first manuscript in this dissertation included a systematic review and meta-analysis examining the effectiveness of eHealth treatments on alcohol and cannabis use outcomes. Across 93 studies (N = 51,833), eHealth treatments demonstrated small but significant effects, with reductions in alcohol use at post-treatment (g = .25) and cannabis use at follow-up (g = .18) relative to controls. The effect for alcohol use at follow-up was minimal (g = .07). Moderator analyses revealed larger reductions in alcohol or cannabis use in studies with an older sample mean age, non-college/university samples, an ARSU inclusion requirement, those published outside of North America, and those incorporating specific treatment components (i.e., motivational interviewing, relapse prevention, cognitive strategies, emotional regulation and mental health support). However, few trials reported on parental status or co-occurring mental health concerns, limiting the ability to examine these factors as potential moderators.

These findings suggest that eHealth treatments are effective in reducing alcohol and cannabis use. However, far less is known about their utility for those with co-occurring mental health concerns and at-risk substance use (ARSU+). Notably, mothers – especially in early motherhood – are rarely represented in extant research. This is concerning given recent elevations in the rates of mental health concerns and at-risk substance use (ARSU) in mothers, as well as unique barriers they face in accessing traditional in-person treatments (Ahmad & Vismara, 2021; Chen et al., 2022; Chmielewska et al., 2021; Ghelbash et al., 2022; Hessami et al., 2022; Joyce et al., 2022; Poole & Isaac, 2001; Racine et al., 2022; Shorey et al., 2021; Yan et al., 2020). Collectively, these findings point to a lack of maternal representation in eHealth research despite a high level of unmet need.

The gaps in research on eHealth treatments for alcohol and cannabis use that were identified in manuscript 1 are further supported by a separate systematic review conducted by Joyce et al. (2025), which examined randomized controlled trials (RCT) of substance use treatments for mothers of young children (aged 0 to 5 years old). This review included eight studies ($N = 900$) and showed promising preliminary evidence. Specifically, integrated treatments for substance use showed small-to-moderate reductions in maternal alcohol use compared to treatment as usual (TAU; in the two included studies), while no difference was observed for cannabis use frequency versus TAU (in the one relevant study). Several studies also reported secondary improvements in maternal mental health outcomes (i.e., depression, general mental health), which were comparable to those observed in TAU conditions. Importantly, none of the included studies evaluated eHealth treatments, despite the potential for these treatments to address accessibility barriers in this population. Although these results are encouraging, limitations including small sample sizes, inconsistent outcome measures, and limited follow-up data were evident. In conjunction with the findings from manuscript 1, these population specific findings underscore the need to examine scalable, accessible treatments for mothers with ARSU+.

While the Building Emotional Awareness and Mental health (BEAM) program was not designed to treat ARSU directly, it is an eHealth mental health and parenting treatment that includes components with potential benefits for this population, such as emotion regulation strategies, psychoeducation, and peer support. Examining how mothers with ARSU+ engage with and respond to BEAM provides a unique opportunity to explore the feasibility and potential usability of single-focus mental health treatments. Building on this rationale, the second manuscript in this dissertation investigates the feasibility and symptom trajectories of BEAM for

mothers with co-occurring depression/anxiety and ARSU versus those with co-occurring depression/anxiety without ARSU.

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CHAPTER FOUR: Randomized Controlled Trial

Introduction

Depression/anxiety and at-risk substance use (ARSU) are common and often co-occur during the postpartum period, posing serious risks for mothers and their infants. An estimated 10-20% of mothers experience postpartum depression (Fisher et al., 2012), 14.9% engage in binge drinking (Board et al., 2023), and 4.1% use cannabis while lactating (Coy et al., 2021). Among those in substance use treatment, nearly 70% report a history of depression (Holbrook & Kaltenbach, 2012), and nearly one in five postpartum mothers with ARSU also experience co-occurring depressive and/or anxiety symptoms (Onah et al., 2016). Given approximately 80% of mothers experience a relapse in substance use following childbirth (Forray et al., 2015; Gopman, 2014), the postpartum period represents a high-risk window for the recurrence of ARSU. However, mothers with ARSU are often underrepresented in research on mental health treatments (Adams et al., 2021). This exclusion has created gaps in our knowledge and highlights the need to evaluate whether existing evidence-based mental health and parenting treatments are appropriate, feasible, and have potential to impact symptom trajectories for mothers with co-occurring mental health concerns and ARSU (ARSU+).

The Case for Scalable and Feasible Mental Health Treatments

Postpartum people remain underrepresented in clinical research, especially in the evaluation of scalable, accessible mental health programs that could serve as a foundation for broader family support (Adams et al., 2021). While rates of maternal ARSU+ increased during the coronavirus disease 2019 (COVID-19) pandemic and have remained elevated since, few studies have examined how mental health and parenting treatments perform among this group of mothers (Ahmad & Vismara, 2021; Joyce et al., 2022; Smith et al., 2022). Even fewer have

explored whether such treatments are feasible when implemented in real-world settings. This represents a missed opportunity to support a high-risk group with treatments that could address maternal mental health needs and help interrupt the intergenerational transmission of mental health concerns.

Existing treatments are primarily siloed, targeting either maternal mental health (d = .36) or parenting skills (d = .33) in isolation, with only modest effects in non-ARSU+-specific populations (MacKinnon et al., 2022a; Penner-Goeke et al., 2020). The limitations of existing treatments may be further compounded for mothers with ARSU+ given high levels of stigma and fear of child apprehension, which often limits disclosure, as well as experiences of prejudicial treatment, sleep deprivation, partner conflict, and low social support (Barnett et al., 2021; Poole & Isaac, 2001). These barriers, and the lack of research specific to mothers with ARSU+, are problematic given links between emotional distress, parenting stress, and substance use through mechanisms such as emotion dysregulation and coping-motivated substance use, as described in self-medication theory (Khantzian, 1997, 2018; Mariani et al., 2014; Suh et al., 2008). As a critical first step toward identifying scalable treatments to support maternal mental health, parenting and substance use outcomes, it is important to evaluate key implementation outcomes (e.g., retention rate, perceived usefulness) and assess whether existing treatments are appropriate, feasible, and show promise in improving symptoms in mothers with ARSU+.

Emerging Evidence for eHealth Treatments

Although mental health and parenting treatments show promise, they remain limited in availability and are often resource-intensive, requiring specialized staff and in-person delivery formats that may not be accessible for all families (Niccols et al., 2012; Reupert et al., 2017). These limitations have prompted a growing interest in eHealth treatments.

Early models of eHealth treatments show promise for treating depression, anxiety, and parenting stress among parents (MacKinnon et al., 2022a). eHealth treatments offer several potential benefits over traditional in-person care including their ability to overcome common treatment barriers such as childcare, geographic location, and long waitlists (Moreland et al., 2021). Acceptable levels of engagement, retention, and satisfaction have been reported across eHealth treatments for parents of children aged 0 to 5 years old (MacKinnon et al., 2022b). Meta-analyses on eHealth treatments also show small-to-medium effects for reducing parental depression (g = .37), anxiety (g = .53), and stress (g = .33; k = 38; MacKinnon et al., 2022a). Similarly, treatments delivered during pregnancy demonstrate positive outcomes (g = .29 for depression; g = .26 for anxiety; k = 17; Silang et al., 2022). Together, these findings suggest that eHealth is a feasible and scalable approach for delivering mental health support to mothers of young children. One promising eHealth treatment that incorporates mental health and parenting skills is the Building Emotional Awareness and Mental health (BEAM) program.

The Building Emotional Awareness and Mental health (BEAM) Program

The BEAM program is an eHealth treatment designed to support mothers by combining mental health treatment with parenting skills. Co-designed with a parent advisory board (PAB) of mothers with lived experience of postpartum mental health concerns (Roos et al., 2021), BEAM connects therapists and mothers in a secure and accessible online setting. BEAM merges telehealth best practices with peer connection to address key treatment barriers and is preferred by parents (MacKinnon et al., 2022b; Rioux et al., 2024; Xie et al., 2023). Core components of BEAM include: (a) expert-led psychoeducational videos adapted from the Unified Protocol (UP) and emotion-focused parenting strategies (Barlow et al., 2017; Farchione et al., 2012; Havighurst et al., 2020); (b) therapist-led weekly telehealth groups to consolidate content and foster support

(Spence et al., 2019; Yardley et al., 2016); (c) a monitored community forum to promote peer connection (Lee & Yu, 2024; Rioux et al., 2024; Smit et al., 2023); (d) symptom monitoring (Abidin, 1990; Kroenke et al., 2003, 2007; Lambert & Harmon, 2018); and (e) suggested assignments to support real-world skill application (Rees et al., 2005). BEAM's transdiagnostic design, focus on mental health and parenting stress, emphasis on peer connection, and inclusion of an anonymous community forum may make it a promising approach for mothers with ARSU+. These features may help reduce stigma and logistical barriers, while supporting emotional regulation and parenting skills. However, BEAM has not yet been evaluated in this high-risk group.

Engagement in BEAM has been high across trials, with most mothers reporting satisfaction with the program's content, usability, and overall usefulness (Joyce et al., 2024; MacKinnon et al., 2022b; Roos et al., 2024; Xie et al., 2023). Sociodemographic predictors of increased engagement include older maternal age and higher household income, while being a first-time parent has been associated with lower BEAM engagement (Horn et al., 2025).

BEAM's effectiveness has been evaluated in four trials involving mothers of children aged 6-36 months. None of the trials excluded mothers with ARSU+, but ARSU was not systematically assessed as an outcome or subgroup. Two studies targeted mothers of children aged 6-18 months (Joyce et al., 2024; Xie et al., 2023), and two focused on mothers of children aged 18-36 months (MacKinnon et al., 2022b; Roos et al., 2024). For mothers of infants aged 6-18 months, an open-pilot trial (n = 46) reported medium-to-large improvements in maternal depression (d = .93), anxiety (d = .58), and parenting stress (d = .63; Xie et al., 2023). A subsequent feasibility randomized controlled trial (RCT; n = 80) compared BEAM to MoodMission, another evidence-based eHealth treatment (Aizenstros et al., 2021; Bakker et al.,

2018b, 2018a; Bakker & Rickard, 2019; Lee & Bakker, 2024; Moggia et al., 2024). Both groups showed improvements in mental health symptoms (depression, anxiety, sleep disturbance, and anger) and parenting stress, but BEAM participants experienced greater reductions in anxiety after controlling for symptom severity at enrollment (Joyce et al., 2024). Among mothers of toddlers (aged 18-36 months), a pilot non-superiority trial found moderate feasibility, with large reductions in maternal depression (d = .47) and moderate reductions in parenting stress (d = .33); 66.7% of participants showed clinical improvements in depression and 52.9% in anxiety (MacKinnon et al., 2022b). A large RCT (n = 119) also found greater reductions in anxiety among mothers in BEAM compared to those in treatment as usual (TAU), although depressive symptoms improved similarly across both groups (Roos et al., 2024).

The Current Study

To date, no study has examined the feasibility of BEAM for mothers with ARSU+ or whether symptom trajectories differ between ARSU groups. Pre-treatment data from Roos et al. (2024) suggest that even in a sample of BEAM participants not recruited for ARSU+, one in seven met clinical cut-offs for ARSU (score $\geq$ 8 on the Alcohol Use Disorder Identification Test; Babor et al., 2001), and one in three reported using cannabis on 25 or more days in the past month (M = 4.9 standard joints/day; Babor et al., 2001; Roos et al., 2024; Zeisser et al., 2012). These findings highlight the high percentage of mothers with ARSU+ already accessing BEAM and underscore the need to examine whether BEAM is appropriate and feasible for this group, and whether symptom trajectories differ for ARSU+ versus ARSU- mothers. Despite this need, few scalable treatments have been evaluated for mothers with ARSU+ (Joyce et al., 2025).

Although this study draws on data from two RCTs evaluating BEAM versus TAU, the present secondary data analysis does not compare mothers with ARSU+ in BEAM to those in

TAU due to differences in the control conditions (i.e., active [MoodMission] versus inactive control [list of community mental health resources]) and limited statistical power.[13] Instead, it focuses exclusively on comparisons within the BEAM arm, specifically between mothers with ARSU+ and ARSU-. This analysis combines data from mothers of infants (6-18 months) and toddlers (18-36 months; Joyce et al., 2024; Roos et al., 2024). By comparing implementation outcomes (e.g., retention rate, perceived usefulness) and symptom trajectories (e.g., depression, anxiety) across ARSU groups, this study provides preliminary insight into whether BEAM could be adapted and scaled to support mothers with ARSU+. This study is the first to examine how implementation outcomes and symptom trajectories differ between mothers with ARSU+ and ARSU- enrolled in BEAM.

Research Questions and Hypotheses

1. *Research Question* 1: Do BEAM implementation outcomes differ between ARSU

[13] Although this power analysis was conducted after data collection, it differs fundamentally from traditional post hoc power calculations, which have been widely criticized for relying on observed *p*-values and/or effect sizes, and for offering no new inferential information (Hoenig & Heisey, 2001). Instead, this analysis used a simulation-based approach via the simr package in R (Green & MacLeod, 2016), which prospectively estimates the ability to detect a theoretical time*trial interaction effect ($\beta = 0.30$) given the study design (i.e., sample size, timepoints, missingness, variance structure). In other words, given the structure of the collected data, could the study have detected a meaningful effect if one were present? Although this analytic model initially included a random slope for time, the simulation was based on a simplified random intercept only model due to convergence issues and singular fit warnings when including random slopes. Under this simplified model, the estimated power to detect a moderate time*trial interaction was only 4% (95% CI = 1.1%-9.9%), demonstrating that the available sample size ($n = 66$) was insufficient to detect between-group differences. Based on this evidence, comparisons between BEAM and TAU ARSU+ participants were not discussed in this dissertation. They are included in Appendix K, however, at the request of a committee member.

groups?[14] Implementation outcomes included: retention rate, perceived usefulness (used as a proxy for procedural acceptability), post-treatment and follow-up questionnaire completion time, overall questionnaire completion, treatment adherence, and safety.

   a. *Hypothesis 1:* Implementation outcomes were expected to be more favorable among ARSU- versus ARSU+ mothers, given those with ARSU+ may face additional barriers to engaging in treatment (Barnett et al., 2021; Poole & Isaac, 2001).

2. *Research Question 2*: Do maternal mental health and parenting stress outcomes differ between ARSU groups? Outcomes included: depression, anxiety, anger, sleep disturbance, and parenting stress.

   a. *Hypothesis 2a*: Both ARSU groups were expected to report reductions in mental health symptoms and parenting stress across time, consistent with prior evidence of symptom improvement associated with BEAM (Joyce et al., 2024; MacKinnon et al., 2022b; Roos et al., 2024; Xie et al., 2023).

   b. *Hypothesis 2b*: It was further hypothesized that mothers with ARSU- would report greater symptom improvements over time compared to those with ARSU+, as substance use has been associated with attenuated treatment response and reduced gains in mental health and parenting treatments, likely due to prominent barriers such as stigma, psychosocial stressors, and high dropout rates (Barnett et al., 2021; Liu et al., 2020; Poole & Isaac, 2001).

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[14] Based on pre-specified group-based criteria, mothers were classified as ARSU+ if they scored $\geq$ 8 on the Alcohol Use Disorder Identification Test (AUDIT; Babor et al., 2001) and/or the Cannabis Use Disorder Identification Test – Revised (CUDIT-R; Adamson & Sellman, 2003) at any timepoint (pre-treatment, post-treatment, follow-up). Mothers with scores < 8 were in the ARSU- group.

Methods

Trial Design

Participants were from two RCTs: the *infant trial*, which compared 10 weeks of BEAM (version 1.0; a combined mental health and parenting program) with MoodMission[15] (a mental health-only program; Aizenstros et al., 2021; Bakker et al., 2018b, 2018a; Bakker & Rickard, 2019; Lee & Bakker, 2024; Moggia et al., 2024); and the *toddler trial*, which compared 10 weeks of BEAM (version 1.0) with TAU, consisting of a list of community mental health resources.[16] Both trials used the same treatment, core procedures, outcome measures, and follow-up periods, supporting their integration for the purposes of this secondary data analysis.

Mothers were recruited between January and March 2022 for the infant trial (Manitoba, Canada), and between November 2021 and February 2022 for the toddler trial (Manitoba and Alberta, Canada). Participants were recruited using paid, targeted advertisements on social media platforms including Facebook, Instagram, Twitter, Pinterest, and Reddit. For the infant trial, recruitment also occurred via poster distribution through the listserv of a local community agency (Family Dynamics) and in locations frequented by mothers in Manitoba, such as the Children's Hospital Research Institute of Manitoba (CHRIM), libraries, parks, community centres, and grocery stores (see Appendix L for the recruitment poster).

Participants were randomized at a 1:1 ratio using a computer-generated randomization schedule (http://www.randomlists.com/team-generator). Blocked randomization was conducted using fixed blocks of 10 which were initiated after 10 participants were enrolled. Enrollment and

[15] MoodMission will not be described here since data from this group were not examined.
[16] We originally planned to only examine data from the infant trial (Joyce et al., 2023); however, due to the small sample size of mothers with ARSU + in the BEAM treatment arm (n = 13), we opted to include data from the toddler trial (Roos et al., 2024).

allocation were completed by a research assistant independent of the BEAM clinical team. Further information on the randomization process is published elsewhere (Joyce et al., 2023; Xie et al., 2022).

Both RCTs were registered with ClinicalTrials.gov (infant [NCT05398107] and toddler [NCT05306626]) and the protocols are published (Joyce et al., 2023; Xie et al., 2022). Ethics approval was obtained from the University of Manitoba's Research Ethics Board (REB) for both the infant (REB #: HE2021-0217) and toddler trials (REB #: P2020:081). Both studies were conducted in accordance with the Declaration of Helsinki.

Participants

Inclusion/Exclusion Criteria

To be eligible for the infant trial, participants had to: 1) be a mother-identifying primary caregiver (biological, adoptive, foster, stepparent)[17]; 2) be ≥18 years old; 3) have an infant 6-18 months old at recruitment; 4) reside in Manitoba, Canada; 5) obtain a score ≥10 on the Patient Health Questionnaire – 9 Item (PHQ-9; Kroenke et al., 2001) or Generalized Anxiety Disorder – 7 Item (GAD-7; Spitzer et al., 2006); 6) complete the Mini International Neuropsychiatric Interview (MINI; Sheehan et al., 1998) and meet diagnostic criteria for a major depressive episode and/or anxiety disorder; 7) complete pre-treatment (T1) questionnaires; 8) be available to attend weekly telehealth groups; and 9) be able to comfortably communicate in English (spoken and written). Participants were excluded if they self-reported a suicide attempt (past year) or self-harm behaviors (past six months). Similarly, participants were excluded if psychotic symptoms, post-traumatic stress disorder, or an alcohol/substance use disorder were identified on the MINI (Sheehan et al., 1998) which would likely interfere with their ability to attend weekly telehealth

[17] To be eligible, participants had to identify as a mother regardless of their sex assigned at birth.

groups and/or benefit from the treatment, based on clinical judgement. BEAM was not developed to treat these mental health conditions and its effectiveness for such concerns have not been evaluated. Participants who were excluded were provided with mental health resources and referred to local services better suited to meet their needs. Referral decisions were made in consultation with the broader clinical team.

Eligibility criteria for the toddler trial were largely identical to those of the infant trial, with the following exceptions, participants must: 1) have a toddler 18-36 months old at recruitment (versus 6-18 months in the infant trial); 2) reside in Manitoba or Alberta, Canada (compared to only Manitoba in the infant trial); 3) consent to wearing a Fitbit (not required in the infant trial and unrelated to the current study); and 4) complete a baseline Zoom assessment and/or orientation session (rather than the MINI in the infant trial).

Across both trials, participants were eligible regardless of any other treatments they were receiving outside the study. No effective treatments were withheld from those who chose to participate in BEAM.

The Building Emotional Awareness and Mental health (BEAM) Program

BEAM is a 10-week guided mental health and parenting skills treatment where mothers progress through weekly modules alongside a cohort of mothers also experiencing depression and/or anxiety. The program teaches skills designed to increase supportive parenting behaviors and promote maternal-child bonding, with the goal of disrupting theorized mechanisms of environmental risk transmission (e.g., positive emotional modelling, improved relationships, support for children's distress, reduced conflict; Roos et al., 2021; Zalewski et al., 2020). BEAM was developed in collaboration with the PAB of the Hearts and Minds Laboratory, as well as our

local community partner (Family Dynamics; for the infant trial only). See Table 5 for an overview of the BEAM program.

Table 5. An overview of the Building Emotional Awareness and Mental health (BEAM) program content

Week of Program	BEAM Content
Week 1	*Why is this so hard?* An introduction to the program. Learn about your mental health, parenting myths, and identifying your personal values.
Week 2	*How do I get motivated?* Learn about setting goals, motivation, and identifying sources of joy to improve your relationship with your child.
Week 3	*The payoff of understanding emotions* Learn about the emotional response and how emotions work, including how to regulate your child's emotions.
Week 4	*Trigger warnings! How do my emotions work?* Walk through the emotional experience (Antecedents, Response, Consequences; ARC) and learn how routines help regulate your child's emotions.
Week 5	*Appreciating the rainbow amidst the storm* Learn about mindful emotional awareness and how to mindfully engage with your child.
Week 6	*Getting Unstuck* Learn about thinking patterns and how to find flexibility to navigate tough situations with your child.
Week 7	*Finding a better path when emotions are high* Learn about countering emotion-driven behaviors and how you can help manage your child's big emotions.
Week 8	*Feeling your feelings* Learn how physical sensations impact your emotional experience, how to face them, and how to stay present when your child has big emotions.
Week 9	*Exploring your opinions* Learn about emotional exposures to help improve coping and skills for helping you and your child cope with tantrums.
Week 10	*Where do I go from here?* Discuss takeaways, evaluate your progress, and learn strategies to maintain your progress. Reflect on ways to feel emotionally balanced as a mom.

Each week of BEAM included the following components:

1. *Psychoeducational Videos*: Participants viewed two weekly videos, one on mental health and the other on parenting skills, totaling 10-30 minutes. These videos were accessed through the BEAM App.[18] Mental health videos incorporated emotion regulation strategies adapted from the UP, an evidence-based transdiagnostic treatment for depressive and anxiety disorders (Barlow et al., 2017; Farchione et al., 2012). Parenting videos introduced emotion-focused and behavioral management strategies to help mothers understand and co-regulate their child's challenging behaviors, prevent negative parent-child interactions, and promote positive relationships (Havighurst et al., 2020).
2. *Symptom Monitoring*: Participants completed weekly items on depression (Patient Health Questionnaire – 2 Item), anxiety (Generalized Anxiety Disorder – 2 Item), parenting stress (a four-item modified version of the Parenting Stress Index), and positive mood (a two-item modified version of the Positive and Negative Affect Scale; Barroso et al., 2016; Kroenke et al., 2003, 2007; Watson et al., 1988). Weekly scores were shared with participants, allowing them to track their progress. Regular symptom monitoring is shown to enhance emotional understanding (Schueller et al., 2021).
3. *Weekly Telehealth Group*: Participants attended weekly telehealth group sessions to review content, discuss challenges and successes with coaches and peers, and build a sense of community (Spence et al., 2019; Yardley et al., 2016).

[18] In the infant trial several mothers experienced technological difficulties in the BEAM App which impacted their ability to access psychoeducation videos. These videos were therefore uploaded onto YouTube to provide mothers with access to the same content.

4. *Community Forum*: An anonymous, closed forum – moderated by peer and parent coaches – allowed participants to reflect on skills, share experiences, and access social support (Lee & Yu, 2024; Rioux et al., 2024; Smit et al., 2023). Parents could also ask peer and parent coaches questions related to mental health and parenting.
5. *Suggested Assignments*: Each week, participants received optional assignments to reinforce learning and encourage skill application (e.g., identifying and incorporating value-based activities into one's life).

Clinical Team

BEAM was supported by a team that included clinical, peer, and parent coaches. Clinical coaches were mental health therapists completing graduate-level training in clinical psychology and were supervised by a registered clinical psychologist; they led/co-led telehealth groups, managed communication with participants, and participated in weekly supervision. Peer coaches were mothers who have struggled with their own mental health, participated in a prior mental health program (Roos et al., 2021), volunteered to support others on their mental health journey, and were compensated for their time. Peer coaches attended telehealth groups and engaged on the community forum. Parent coaches were included in the infant trial only. They were trained mental health professionals working at our local community partner (Family Dynamics) who delivered therapy and taught parenting skills as part of their job. Parent coaches co-led telehealth groups and engaged on the community forum.

Measures[19]

See Table 6 for a schedule of assessment administration.

[19] Only questionnaires relevant to this dissertation are presented versus all questionnaires from the two included studies. For information on all questionnaires that were administered, please see Joyce et al. (2023) and Xie et al. (2022).

Table 6. Schedule for assessment administration

	STUDY PERIOD					
	Enrollment (T0)	**Pre-Treatment (T1)**	**Allocation**	**Treatment**	**Post-Treatment (T2)**	**Follow-Up (T3)**
TIMEPOINT	***Week 0***	***Weeks 1-8***	**Week 9**	***Weeks 9-19***[v]	***Weeks 19-21***	***Weeks 32-34***
Participant Demographics						
Breast/Chest feeding Questionnaire[a]						X
Recent Stressful Experiences[a]		X			X	X
Sociodemographics[a]		X				
Substance Use Questionnaire[a]		X			X	X
Implementation Outcomes						
mHealth App Usability Questionnaire[b]					X	
Mother						
Alcohol Use Disorder Identification Test[c]		X			X	X
Cannabis Use Disorder Identification Test – Revised[d]		X			X	X
Generalized Anxiety Disorder – 7 Item[e]	X	X			X	X
Mini International Neuropsychiatric Interview[f,g]	X					
Patient Health Questionnaire – 9 Item[h]	X	X			X	X
Patient Reported Outcomes Measure Information System (PROMIS) – Anger Subscale[i]		X			X	X
Patient-Reported Outcomes Measure Information System (PROMIS) – Sleep Disturbance Subscale[j]						
Parenting						
Parenting Stress Index – Short Form[k]		X			X	X
Weekly Mood Tracking						
Generalized Anxiety Disorder – 2 Item[l]				X		
Patient Health Questionnaire – 2 Item[m]				X		
Positive and Negative Affect Scale (modified 2-item scale)[n]				X		
Parenting Stress Index (modified 4-item scale)[k]				X		

Note: [a]Author-Compiled Questionnaires; [b]Zhou et al. (2019); [c]Babor et al. (2001); [d]Adamson & Sellman (2003); [e]Kroenke et al. (2007); [f]Sheehan et al. (1998); [g]Only used for the infant trial; [h]Kroenke et al. (2003); [i]Pilkonis et al., 2011; [j]Hanish et al., 2017; [k]Abidin (2012); [l]Kroenke et al. (2001); [m]Spitzer et al. (2006); [n]Watson et al. (1988)

Participant Characteristics

Sociodemographics. Data on maternal demographics (e.g., age, marital status, highest level of education, ethnicity, employment status), child demographics (e.g., child sex, age of child), and household demographics (e.g., number of adults and children in the household, annual household income, community type) were collected to characterize the sample.

Breast/Chest Feeding Questionnaire[20]**.** Breast/chest feeding status was assessed using an author-compiled item administered at three time points: pre-treatment (T1), post-treatment (T2), and at follow-up (T3).

Recent Stressful Experiences (RSE). The author-compiled RSE measure was developed based on expert recommendations from the Centre on the Developing Child at Harvard University. The RSE assessed the frequency of family stressors (e.g., life-threatening illness, accidental injury to you or someone else) experienced over the past month and past two to 12 months. Items were scored dichotomously (1 = yes, 0 = no), and a cumulative stress score was calculated by summing the number of endorsed stressors. A resiliency subscale was also included, in which items were scored on a 5-point Likert scale from 1 ("*Not at all like me*") and 5 ("*Exactly like me*"). Higher total summative scores indicated greater resilience. Internal consistency for the resiliency subscale was adequate in this study ($\alpha = 0.65$).

Substance Use Questionnaire. In both trials, participants reported alcohol use and cannabis use (1= yes, 0 = no) in the past 6 months via the Alcohol Use Disorder Identification Test (AUDIT) and Cannabis Use Disorder Identification Test – Revised (CUDIT-R; see below for further information on these two measures; Adamson & Sellman, 2003; Babor et al., 2001).

[20] The term breast/chest feeding was used to promote inclusivity, as participants had to identify as mothers but there was no restriction on sex assigned at birth.

Cannabis use quantity was assessed using the standardized joint definition identified by Zeisser et al. (2012). Measurement of tobacco and illicit drug use differed slightly between the two trials. In the infant trial, participants were asked a categorical yes/no question, while the toddler trial used open-text questions to assess the number of days the individual used tobacco and illicit drugs during the past month (see Appendix M for full item wording).

Implementation Metrics

Implementation metrics were calculated using back-end BEAM App data from Google Analytics and Firebase as well as the Research Electronic Data Capture (REDCap; Harris et al., 2009, 2019). Data was assessed descriptively between the ARSU+ and ARSU- groups (see Table 7 for definitions) and included: retention rate, perceived usefulness, questionnaire completion time at T2 and T3 (in minutes), questionnaire completion, treatment adherence, and safety. Each outcome was evaluated against an *a-priori* benchmark to compare BEAM usability between ASRU groups (Joyce et al., 2023).[21] Weekly telehealth group attendance was recorded by the clinical team (1 = present, 0 = absent).

mHealth App Usability Questionnaire (MAUQ). The MAUQ is an 18-item measure which assessed participants perceptions of BEAM (Zhou et al., 2019). It includes three subscales, which demonstrated adequate internal consistency in this study: ease of use (α = .94), interference and satisfaction (α = .94), and usefulness (α = .90; Zhou et al., 2019). The MAUQ has been previously validated, with subscale reliability coefficients ranging from α = 0.82 - 0.91 (Zhou et al., 2019). Items were scored on a 7-point Likert scale ranging from 0 ("*Strongly*

[21] Despite outlining processing time as a feasibility indicator in our protocol (Joyce et al., 2023), we did not have the data required to calculate this variable due to an error tracking processing time in REDCap (Harris et al., 2009, 2019).

Agree") to 7 ("*Strongly Disagree*"), with lower scores reflecting more positive views toward BEAM.

Table 7. Implementation metrics

Implementation Metric	Indicator	Criteria for Success	ARSU+	ARSU-
			M(SD) / %	M(SD) / %
Retention Rate	% of mothers with data at follow-up	≥ 80% of mothers with follow-up data	72.7%	76.6%
Perceived Usefulness	Usefulness subscale of mHealth App Usability Questionnaire[a]	Mean score of ≤ 3	3.1 (2.0)	3.1 (1.3)
Post-Treatment Questionnaire Completion Time	**Time to complete post-treatment questionnaires**	**Mean of < 60 minutes to complete**	**37.1 (15.7)**	**43.8 (26.5)**
Follow-Up Questionnaire Completion Time	**Time to complete follow-up questionnaires**	**Mean of < 60 minutes to complete**	**18.5 (9.5)**	**18.7 (15.7)**
Questionnaire Completion	% of missing data among program completers	> 80% of data is present among mothers who completed follow-up	71.5%	76.6%
Treatment Adherence	**Logging onto the BEAM App and/or attending weekly group telehealth session**	**Participation in > 50% of program weeks via logging onto the BEAM App or attending weekly telehealth group sessions**	**87.9%**	**91.8%**
Safety	**Adverse events from the BEAM program or assessments**	**No adverse events reported through the risk-management protocol**	**0 adverse events reported**	**0 adverse events reported**

Note: [a]Zhou et al. (2019); Results meeting pre-specified criteria for success are in bold.

Clinical Outcome Measures

Alcohol Use Disorder Identification Test (AUDIT). The AUDIT is a 10-item questionnaire used to assess alcohol consumption, drinking behaviors, and alcohol-related problems (Babor et al., 2001). Response anchors vary across items, and total scores are calculated by summing all items. A score of $\geq$ 8 indicates hazardous or harmful alcohol use (Babor et al., 2001). The AUDIT has good test-retest reliability over a 6-week interval (r = .81; Daeppen et al., 2000) and demonstrated adequate internal consistency across all timepoints in this study (α's = 0.69 - 0.78).

Cannabis Use Disorder Identification Test – Revised (CUDIT-R). The CUDIT-R is an eight-item measure which assesses at-risk cannabis use (Adamson & Sellman, 2003). Items were scored on a 5-point scale ranging from 0 ("*Never*") to 4 ("*Daily/Almost Daily*"), and total scores are calculated by summing all items. Scores between 8 and 11 indicate hazardous cannabis use, while scores of $\geq$12 suggest a probable Cannabis Use Disorder (Adamson & Sellman, 2003). The CUDIT-R has strong test-retest reliability between 6- and 12 months (r = .85 and .87, respectively; Adamson & Sellman, 2003) and demonstrated adequate internal consistency across all timepoints in this study (α's = 0.79 - 0.85).

Generalized Anxiety Disorder – 7 (GAD-7). Anxiety symptom severity was assessed using the GAD-7, a seven-item measure that asks participants to report the frequency of their anxiety symptoms over the past two weeks (Spitzer et al., 2006). Items were scored on a 4-point Likert scale from 0 ("*Not at all*") to 3 ("*Nearly every day*"). Total scores are calculated by summing all items, with higher scores indicating greater symptom severity. Scores are interpreted as follow: 0-4 = minimal anxiety, 5-9 = mild anxiety, 10-14 = moderate anxiety, and 15-21 = severe anxiety (Spitzer et al., 2006). The GAD-7 demonstrated adequate internal

consistency across all timepoints in this study (α's = 0.88 - 0.90) and has shown good test-retest reliability in prior research (ICC = .83; Spitzer et al., 2006).

Mini International Neuropsychiatric Interview for DSM-5 (MINI). The MINI is a structured diagnostic interview used to assess mental health disorders (Sheehan et al., 1998) and was used here to determine participant eligibility in the infant trial (Sheehan et al., 1998). The MINI is based on the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; American Psychological Association, 2013) which was adapted from the Fourth Edition (DSM-IV; American Psychiatric Association, 1994). Psychometric data for the DSM-5 version of the MINI has not been published. Good interrater and test-retest reliability has been demonstrated for the MINI based on the DSM-IV, however (Lecrubier et al., 1997; Sheehan et al., 1998). Pre-specified modules of the MINI were administered.[22]

Parenting Stress Index – Short Form (PSI-SF). The Parent-Child Dysfunctional Interaction subscale of the PSI-SF consists of 12 items that examined the extent parents felt satisfied with their child and interactions with their child (Barroso et al., 2016). Items were rated on a 5-point Likert scale from 1 ("*Strongly Disagree*") to 5 ("*Strongly Agree*"), with higher total scores indicating greater dysfunction in the parent-child relationship. This subscale had adequate internal consistency across all timepoints in this study (α's = 0.80 - 0.83) and has shown adequate test-retest reliability in prior research (*r* = .66; Barroso et al., 2016).

Patient Health Questionnaire – 9 Item (PHQ-9). The PHQ-9 includes nine-items that examined the severity of one's depressive symptoms during the past two weeks (Kroenke et al.,

[22] Major depressive episode, suicidality, generalized anxiety disorder, panic disorder, agoraphobia, social anxiety disorder, post-traumatic stress disorder, alcohol use disorder, substance use disorder, and psychotic disorder and mood disorders with psychotic features.

2001). Items were scored on a 4-point Likert scale ranging from 0 ("*Not at all*") to 3 ("*Nearly every day*"), where higher summative scores indicate more severe depressive symptoms. Scores are interpreted as follows: 0-4 = minimal depression, 5-9 = mild depression, 10-14 = moderate depression, 15-19 = moderately severe depression, and 20-27 = severe depression (Kroenke et al., 2001). The PHQ-9 demonstrated adequate internal consistency across all timepoints in this study (α's = 0.78 - 0.88) and has shown strong test-retest reliability over a 48-hour period in prior research (r = .84; Kroenke et al., 2001).

Patient-Reported Outcomes Measure Information System (PROMIS) - Anger Subscale. The five-item Patient-Reported Outcomes Measure Information System (PROMIS) - Anger subscale assessed anger, negative social cognitions, and efforts to control anger (Pilkonis et al., 2011). Items were scored on a 5-point scale ranging from 1 ("*Never*") to 5 ("*Always*"), with higher total scores indicating greater anger-related distress. The PROMIS - Anger subscale demonstrated adequate internal consistency across all timepoints in this study (α's = 0.82 - 0.91) and has been validated in prior research (r = .51; Pilkonis et al., 2011).

Patient-Reported Outcomes Measure Information System (PROMIS) - Sleep Disturbance Subscale. The eight-item PROMIS - Sleep Disturbance subscale examined participants' perceptions on their sleep quality, depth, and restorative value (Hanish et al., 2017). Items were scored on a 5-point Likert scale from 1 ("*Not at all*") to 5 ("*Very Much*"), with several items reverse scored. Higher total scores indicated greater sleep disturbances. The PROMIS - Sleep Disturbance subscale demonstrated adequate reliability across timepoints in this study (α's = 0.89 - 0.90) and have been validated in prior research (r = .83; Buysse et al., 2010; Yu et al., 2011).

Procedure

Table 8 depicts the schedule of enrollment, interventions, and assessments for both trials, in accordance with the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) reporting guidelines (Chan et al., 2013a; 2013b).

Table 8. Standard protocol items: recommendations for interventional trials (SPIRIT) schedule of enrollment, interventions, and assessments

	STUDY PERIOD				
	Enrollment	**Allocation**	**Treatment**	**Post-Treatment**	**Follow-Up**
TIMEPOINT	***Weeks 1-8***	**Week 9**	***Weeks 9-19***	***Weeks 19-21***	***Weeks 32-34***
ENROLLMENT					
Informed Consent	X				
Eligibility Screener	X				
Psychodiagnostic Mental Health Assessment[1]	X				
Allocation		X			
TREATMENT					
BEAM Program			X		
ASSESSMENTS					
Treatment Outcome Questionnaires	X			X	X

[1]The psychodiagnostics interview, i.e., the Mini International Neuropsychiatric Interview (Sheehan et al., 1998), was only conducted with mothers in the infant trial.

At enrollment (T0), mothers completed an online screening questionnaire that included sociodemographic information, a suicidality/self-harm screener, the PHQ-9 (Kroenke et al., 2001), and the GAD-7 (Spitzer et al., 2006) to determine initial eligibility. Informed consent was obtained electronically via the REDCap system (Harris et al., 2009, 2019) at three timepoints: 1) prior to completing the enrollment (T0) screener, 2) before beginning the MINI (only in the infant trial), and 3) at study enrollment. Participants were informed that participation was voluntary, and that they could revoke their consent or withdrawal from the study at any time without consequence. They were encouraged to contact the research team with any questions or concerns before signing the consent form, and all participants received a copy of the signed consent document via email for their reference.

Individuals who met enrollment (T0) screener eligibility were invited to complete the MINI via Zoom Healthcare with trained research personnel (Sheehan et al., 1998). Participants who met diagnostic criteria for a major depressive episode and/or an anxiety disorder were eligible to participate. Those who did not meet eligibility criteria were provided with a list of local mental health resources in accordance with current standards of care.

Eligible participants were invited to complete self-report measures via the REDCap system (Harris et al., 2009, 2019). Data was collected at T1, T2, and T3. All participants were invited to complete these measures regardless of BEAM treatment completion. See Table 6 for a full list of administered questionnaires. Between T1 and T2 participants engaged in BEAM, as described above. To support retention and acknowledge participants' time, compensation of $\leq$\$160 Canadian Dollars was provided in both trials. The compensation structure differed

between trials, however.[23]

A risk-management protocol was put in place to address potential mental health crises or disclosure of child maltreatment during BEAM trials. This protocol outlines the procedures for identifying and responding to high-risk situations (see Appendix N for the full risk-management protocol).

Data Analysis

Sample Size

A sample size calculation was not conducted, as such calculations are not appropriate for pilot and feasibility studies (Kunselman, 2024). A target sample size of at least 30 participants per ARSU group was selected based on prior recommendations and was deemed sufficient to establish feasibility of BEAM (Billingham et al., 2013; Whitehead et al., 2016).

Scoring and Variable Preparation

Prior to conducting analyses, participants were subdivided into ARSU group based on their AUDIT and CUDIT-R scores. Participants were categorized into the ARSU+ group if they scored ≥8 on the AUDIT or CUDIT-R at T1, T2, or T3 (Adamson & Sellman, 2003; Babor et al., 2001); all others were categorized as ARSU-. For each mental health and parenting stress measure, percent possible scores were calculated by subtracting the scale's minimum possible score from each participant's score and then dividing the result by the scale's maximum possible

[23] In the infant trial, participants were compensated: $25 for the MINI, $25 for T1 questionnaires, $50 for T2 questionnaires, $25 for T3 questionnaires, $25 for completing > 75% of the weekly surveys, and $10 for those who completed the T2 and T3 questionnaires within one week of distribution. In the toddler trial, participants were compensated: $30 for T1 questionnaires and the Zoom assessment, $30 for T2 questionnaires, $30 for T3 questionnaires, and ≤$30 for weekly symptom monitoring ($3 per survey or $30 for all weeks). Participant were offered $50 for returning their Fitbit; alternatively, they could opt to keep the Fitbit in lieu of this $50 compensation.

score. A composite mental health score was then calculated by averaging the percent possible scores across all four mental health measures (i.e., PHQ-9, GAD-7, PROMIS - Anger, PROMIS - Sleep Disturbance; Roos et al., 2024). Alcohol and cannabis use outcomes could not be examined as this data was not collected.

Implementation Metrics

Implementation outcomes were evaluated by comparing the observed values to *a-priori* benchmarks of success (Table 7; Joyce et al., 2023). All feasibility metrics were dichotomized as "success" or "revise" based on these criteria. Benchmarks were then compared between mothers with ARSU+ and ARSU- to examine group differences. Post-hoc descriptive analyses were also conducted on self-reported technological difficulties with the BEAM App (collected in the infant trial only) to explore possible finding explanations.

Symptom Outcomes and Between-Group Differences

Descriptive and inferential statistics were conducted in the Statistical Package for the Social Sciences (SPSS; version 29; IBM Corporation, 2021). An alpha level of .05 was used to indicate statistical significance. Given the exploratory nature of this trial, p-values were not adjusted for multiple comparisons, consistent with existing recommendations for feasibility research (Perneger, 1998; Steiner & Norman, 2011). Independent sample *t*-tests and chi-square tests were used to identify group differences between ARSU groups at T1. Bivariate correlations were then conducted between sociodemographic variables that significantly differed between groups at T1 and symptom change scores (T2-T1 and T3-T1).

To evaluate symptom trajectories over time and potential ARSU group differences, two-level linear mixed models were conducted using MPlus (version 8.4; Muthén & Muthén, 2023) using the maximum likelihood estimator which is robust to non-normality. Multilevel modeling

(MLM) was selected due to the nested structure of the data, with repeated assessments (T1 to T3) nested within individuals. This approach accounts for within-subject correlations, includes all participants even in the presence of missing timepoints, and estimates fixed (e.g., time, ARSU group, and their interaction) and random effects (e.g., individual variation in enrollment symptom severity). Models examined the main effect of ARSU group and time (T1 to T3) on mental health and parenting stress symptoms, and ARSU group as a moderator of the symptom change slope across time (T1 to T3). Sociodemographic covariates that significantly differed by ARSU group at T1 were then included as moderators (i.e., interacting with time and ARSU group) for all models.

A second set of models added T0 symptom severity to the first models. T0 symptom severity was calculated as the average percent possible score for the PHQ-9 and GAD-7 at T0 (i.e., to capture a composite indicator of internalizing symptoms). T0 symptom severity was added as a control (direct effect) of symptoms across time (T1 to T3). Symptom severity was also added as a moderator of the symptom change slope across time (T0 symptom severity x time). This moderation allowed for the examination of whether symptom change may differ as a function of T0 symptom severity. Finally, T0 symptom severity was added in a three-way T0 symptom severity x ARSU group x time interaction alongside ARSU group and the symptom change slope across time, to examine whether T0 symptom severity differentially affected the slope of symptom change between ARSU groups (Landau et al., 2018).

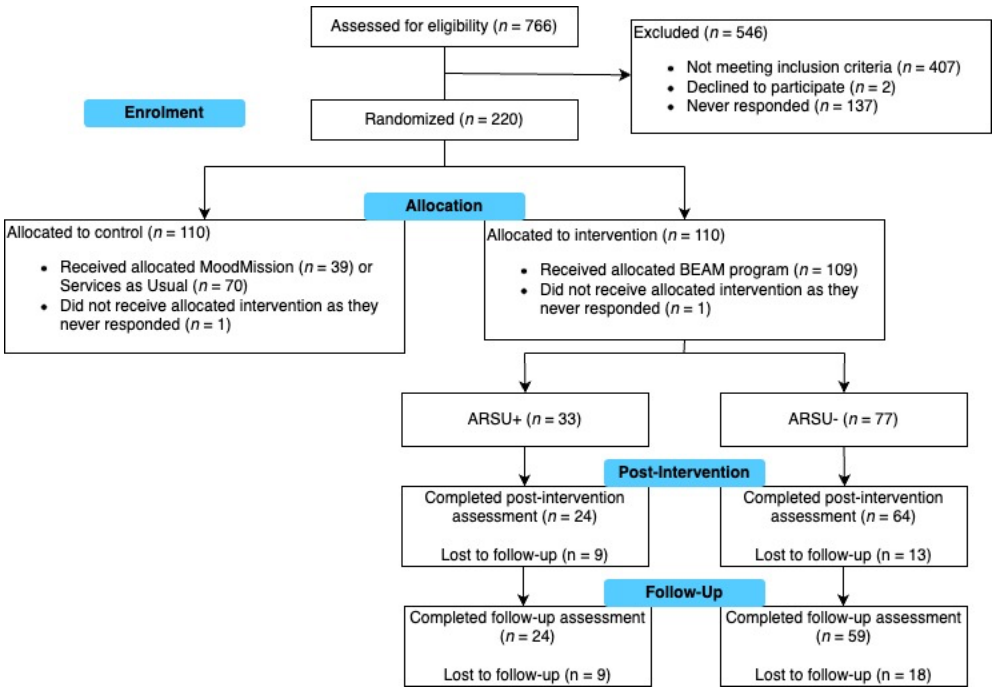
An intention-to-treat approach was used following the Consolidated Standards of Reporting Trials (CONSORT) guidelines, such that all randomized participants were included in analyses regardless of treatment adherence or attrition (Eldridge et al., 2016; Thabane et al., 2016).

Results

Participant Flow

Participant enrollment, allocation, and retention are shown in the CONSORT flow diagram (Figure 8). A total of 235 and 531 mothers completed the enrollment screener for the infant and toddler trials, respectively. Of these, 80 (infant) and 140 (toddler) were randomized. Of the 110 mothers who partook in BEAM (40 from the infant and 70 from the toddler trial), 33 mothers were in the ARSU+ group and 77 were in the ARSU- group. Attrition did not differ by ARSU group at T2, χ^2 (1,110) = 1.56, p = .21, or T3, χ^2 (1,110) = 0.19, p = .66.

Figure 8. Consolidated standards of reporting trials (CONSORT) flow diagram depicting participation



Missing Data

A total of n = 48 participants (43.6%) had at least some missing data, with 15.3% of data cells missing overall.[24] Missing data were handled using the full information maximum likelihood estimation (FIML). FIML is a well-established approach that is robust under the assumption that data are missing completely at random (MCAR; Dong & Peng, 2013; Enders, 2022; Rioux & Little, 2021). Indeed, Little's MCAR test indicated that mental health and parenting outcomes were MCAR, $\chi^2(58) = 70.64$, $p = .12$ (Little, 1988). This supports the appropriateness of FIML as there was no evidence that missingness was dependent on observed or unobserved variables. FIML uses all available data to estimate model parameters without imputing missing values, thereby minimizing bias and improving statistical efficiency while preserving sample size (Enders, 2022; Rioux & Little, 2021).

Sociodemographic Characteristics

Table 9 presents the sociodemographic characteristics for all BEAM participants. On average, mothers were 32.50 years old (SD = 5.12), and their index child was 20.72 months old (SD = 9.19). Households included an average of 2.02 adults and 2.08 children. Most mothers were married or common law (83.2%), White (62.7%), employed (67.9%), and had education beyond a high school diploma (93.6%). A minority breast/chest fed during study participation (39.3%). Household income was high, with 43.4% reporting an annual income > $90,000 Canadian Dollars. Mothers reported experiencing an average of 2.35 (SD = 1.80) RSE in the past year, and moderate levels of resiliency (M = 14.38 out of 25).

[24] The percentage of missing primary outcome data was as follows: anxiety (14.8%), depression (14.8%), sleep (15.2%), anger (15.2%), parenting stress (14.8%), and mental health composite (14.8%). Comparisons of T1 sociodemographic characteristics between participants with and without missing data on primary outcomes revealed no significant differences, suggesting that missingness was not dependent on sociodemographic factors.

Sociodemographic characteristics by ARSU group and group comparisons are shown in Table 9. Mothers with ARSU+ were more likely to be unemployed and to breast/chest feed (*p's* = .03). No other significant differences were identified between ARSU groups.

Table 9. Pre-treatment demographics by group

Sociodemographic Characteristics	**Group**			***Group Comparison (t or χ^2)***
	Sample (*n* = 110)	**At-Risk Substance Use (*n* = 33)**	**No At-Risk Substance Use (*n* = 77)**	
Trial (Infant, %)	36.4%	42.4%	33.8%	$\chi^2 = 0.75$, $p = .39$
Child Sex (%)				$\chi^2 = 0.51$, $p = .78$
Female	50.0%	51.5%	50.6%	
Male	49.1%	48.5%	48.1%	
Twins	0.9%	0%	1.3%	
Child Age (months) (*M, SD*)	20.72 (9.19)	19.57 (9.05)	19.71 (8.79)	$t(107) = 1.16$, $p = .25$
Mother Age (years) (*M, SD*)	32.50 (5.12)	30.82 (4.73)	32.30 (4.60)	$t(103) = 1.15$, $p = .25$
Married/Common Law (%)	83.2%	84.4%	82.7%	$\chi^2 = 0.05$, $p = .83$
Urbanicity (%)	58.2%	51.5%	61.0%	$\chi^2 = 0.86$, $p = .35$
White (%)	62.7%	54.5%	66.2%	$\chi^2 = 1.35$, $p = .25$
Employed (%)	**67.9%**	**51.5%**	**71.4%**	**$\chi^2 = 4.61$, $p = .03$**
Household Income > 90K Canadian (%)	43.4%	30.3%	48.6%	$\chi^2 = 2.75$, $p = .10$
Highest Education (%)				$\chi^2 = 1.79$, $p = .88$
Some high school	6.4%	6.1%	6.5%	
High school	20.0%	27.3%	16.9%	
College/Technical school	30.9%	30.3%	31.2%	
Bachelor's degree	30.9%	27.3%	32.5%	
Graduate or Professional degree	7.3%	6.1%	7.8%	
Number of Adults in Home *(M, SD)*	2.02 (0.73)	2.03 (1.05)	2.03 (0.63)	$t(108) = -0.11$, $p = .91$
Number of Children in Home *(M, SD)*	2.08 (1.17)	1.73 (0.80)	1.99 (1.12)	$t(108) = 0.12$, $p = .90$
Breast/Chest Feeding (%)	**39.3%**	**61.5%**	**29.3%**	**$\chi^2 = 8.86$, $p = .03$**
Accessed Mental Health or Parenting Resources since Treatment Ended – Follow-Up (%)	65.1%	64.0%	65.6%	$\chi^2 = 0.02$, $p = .89$
Recent Stressful Experiences *(M, SD)*	2.54 (1.80)	2.79 (1.63)	2.43 (1.86)	$t(108) = 0.96$, $p = .34$
Recent Stressful Experiences – Resiliency Scale *(M, SD)*	14.38 (3.39)	15.00 (3.39)	14.11 (3.37)	$t(107) = -1.27$, $p = .21$
Symptom Severity (Pre-Treatment) – Percent Possible (*M, SD*)	0.67 (0.16)	0.65 (0.17)	0.67 (0.16)	$t(108) = 0.61$, $p = .55$

Note: Significant results are bolded.

Substance Use Characteristics

At T1, substance use was examined in all BEAM participants. Eighty-five mothers (77.27%) reported alcohol use and 44 (40.00%) used cannabis in the past six months. Among those using cannabis, BEAM participants used an average of 2.89 (*SD* = 5.40) standard cannabis joints in the past month. Mothers in the ARSU+ group were more likely to use cannabis at T1 (yes/no; $\chi^2 = 29.55$, $p < .001$) and T2 ($\chi^2 = 23.17$, $p < .001$). Alcohol use did not differ between ARSU groups at either timepoint (*p*'s > .05).

In the infant trial, 15.00% of mothers were currently using tobacco products, and none used illicit substances. In the toddler trial, 32.43% reported using tobacco (*M* = 8.32 days, *SD* = 13.12) and two used illicit substances (*M* = 0.32 days, *SD* = 1.16) in the past month.

Program Engagement

Table 10 presents BEAM program engagement metrics. On average, mothers who participated in BEAM completed 7.90 weekly symptom monitoring surveys, attended 5.95 weekly telehealth groups, viewed 3.18 mental health videos (at least halfway; out of 10), and viewed 2.37 parenting videos (at least halfway; out of 10). Mothers with ARSU+ completed fewer weekly symptom monitoring surveys ($t_{(61)} = 2.28$, $p = .03$), attended fewer weekly telehealth groups ($t_{(105)} = 3.16$, $p = .002$), and accessed the community forum less often ($t_{(107)} = 2.30$, $p = .02$), compared to mothers in the ARSU- group.

On the MAUQ, all mothers reported the BEAM App was easy to use (*M* = 2.04, *SD* = 1.41; cutoff score $\geq$ 3) and reported high satisfaction (*M* = 2.20, *SD* = 1.38; cutoff score $\geq$ 3), while perceived usefulness was slightly above the cut-off (*M* = 3.07, *SD* = 1.48; cutoff score $\geq$ 3). No significant differences were identified between ARSU groups (*p's* > .12).

Table 10. Means and standard deviations of the BEAM program engagement metrics

Engagement Metric	BEAM		
	Total Sample ***M*** **(*SD*)**	**ARSU+** ***M*** **(*SD*)**	**ARSU-** ***M*** **(*SD*)**
Number of Weekly Surveys Completed	7.90 (3.30)	**6.70 (3.50)**	**8.60 (3.00)**
Total Community Forum Views	70.08 (110.25)	**33.88 (71.95)**	**85.80 (120.28)**
Time on Mental Health Videos (in minutes)	37.93 (51.38)	30.48 (46.62)	41.20 (53.31)
Total Mental Health Videos Watched ≥ 50%	3.18 (3.49)	2.20 (3.04)	3.51 (3.59)
Time on Parenting Videos (in minutes)	27.22 (39.97)	18.75 (31.81)	30.90 (42.71)
Total Parenting Videos Watched ≥ 50%	2.37 (3.06)	1.30 (2.41)	2.73 (3.19)
Number of Weekly Telehealth Groups Attended	5.95 (3.55)	**4.39 (3.82)**	**6.65 (3.22)**

Note: Significant group differences are bolded

Implementation Metrics

Among both ARSU groups, implementation benchmarks for BEAM were met for T2 and T3 questionnaire completion time (≤60 minutes to complete), treatment adherence (>50% of program weeks completed), and safety (no adverse events reported; Table 7). However, neither group met the pre-specified criteria for retention rate (≥80% with follow-up data), perceived usefulness of the BEAM App (score of ≤3 on the MAUQ), or questionnaire completion (>80% with follow-up data).

Post hoc analyses revealed that 31.3% of mothers in the infant trial reported difficulties accessing mental health and parenting videos through the BEAM App. Notably, 60% of these mothers reported they did not watch the mental health/parenting videos when offered on YouTube when uploaded by the clinical team in response to unexpected technical difficulties in the BEAM App.

Symptom Outcomes

As shown in Table 11, there were significant moderate positive correlations between T0 symptom severity and anxiety, depression, anger, and sleep disturbance scores at T1 (*p's* < .05) in BEAM participants, thus motivating the pre-specified moderation by T0 symptom severity (Joyce et al., 2023). No other T1 sociodemographic variables were associated with mental health symptoms or symptom change across time.

Table 11. Bivariate correlations between sociodemographics and change in mental health outcomes

	Employed	Symptom Severity (at eligibility/T0)	Breast/Chest Feeding
Anxiety[a] (T1)	-.036	**.498*****	-.002
Anxiety[a] (T2-T1)	-.041	.006	-.014
Anxiety[a] (T3-T1)	.042	-.058	-.041
Depression[b] (T1)	-.126	**.520*****	-.105
Depression[b] (T2-T1)	.033	-.096	.021
Depression[b] (T3-T1)	.115	-.141	.065
Anger[c] (T1)	-.040	**.365*****	.005
Anger[c] (T2-T1)	-.053	-.061	-.087
Anger[c] (T3-T1)	.029	.026	.003
Sleep[d] (T1)	.594	**.360*****	.071
Sleep[d] (T2-T1)	.050	-.001	-.057
Sleep[d] (T3-T1)	.084	-.085	-.065
Parenting Stress[e] (T1)	.093	.037	-.079
Parenting Stress[e] (T2-T1)	-.142	.094	.095
Parenting Stress[e] (T3-T1)	-.113	.050	.136

Measured using the [a]Generalized Anxiety Disorder – 7 Item (Spitzer et al., 2006), [b]Patient Health Questionnaire – 9 Item (Kroenke et al., 2001), [c]PROMIS-Anger (Pilkonis et al., 2011), [d]PROMIS-Sleep Disturbance (Hanish et al., 2017), [e]Parenting Stress Index - Short Form (Barroso et al., 2016)
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.
Note: T1 = Pre-treatment; T2 = Post-treatment; T3 = Follow-up

At-Risk Substance Use Group Differences

Table 12 presents the mean and standard deviations of mental health and parenting stress outcomes by ARSU group across all timepoints. As expected, scores on the AUDIT and CUDIT-R were consistently higher in the ARSU+ group, versus ARSU-, which is consistent with the group classification criteria. No other between-group differences were observed for mental health or parenting stress outcomes at any timepoint.

Table 12. Mental health and parenting stress outcomes by group across data collection timepoints

	Overall			At-Risk Substance Use			No At-Risk Substance Use			Clinical
Variable	***M* (*SD*)**	**Min.**	**Max.**	***M* (*SD*)**	**Min.**	**Max.**	***M* (*SD*)**	**Min.**	**Max.**	**Cut-offs**
***Anxiety*[a]**										≥ 10
Pre-Treatment	13.75 (5.19)	2	21	14.55 (5.50)	3	21	13.40 (5.06)	2	21	
Post-Treatment	8.90 (5.85)	0	21	10.29 (5.72)	2	21	8.37 (5.06)	0	21	
Follow-Up	7.63 (5.45)	0	21	7.88 (6.10)	0	21	7.53 (5.22)	0	21	
***Depression*[b]**										≥ 10
Pre-Treatment	13.78 (5.01)	3	25	14.79 (5.61)	3	25	13.35 (4.70)	4	25	
Post-Treatment	9.52 (5.25)	1	24	9.87 (5.12)	3	23	9.39 (5.37)	1	24	
Follow-Up	7.99 (5.60)	1	24	8.38 (5.82)	1	24	7.83 (5.55)	1	24	
***Anger*[c]**										≥ 16
Pre-Treatment	17.45 (2.93)	9	25	18.00 (3.09)	9	23	17.22 (2.85)	9	25	
Post-Treatment	15.80 (3.68)	9	25	14.87 (2.82)	9	19	16.14 (3.91)	10	25	
Follow-Up	14.72 (4.09)	7	25	14.54 (4.64)	7	25	14.80 (3.88)	8	25	
***Sleep Disturbance*[d]**										≥ 30
Pre-Treatment	28.95 (6.57)	15	40	29.39 (6.34)	17	39	28.75 (6.70)	15	40	
Post-Treatment	25.92 (7.03)	8	40	26.26 (8.00)	12	40	25.80 (6.71)	8	40	
Follow-Up	23.13 (7.21)	8	40	21.50 (6.68)	8	40	23.80 (7.37)	9	40	
***Parenting Stress* Index – Parent-Child Dysfunctional Interaction Subscale[e]**										-
Pre-Treatment	20.02 (5.95)	12	40	20.39 (5.61)	12	35	19.86 (6.12)	12	40	
Post-Treatment	19.00 (5.83)	12	36	18.96 (6.88)	12	34	19.02 (5.44)	12	36	
Follow-Up	18.86 (6.25)	12	42	20.58 (6.85)	12	42	18.15 (5.90)	12	42	
Mental Health Composite										-
Pre-Treatment	0.65 (0.13)	0	1	0.68 (0.15)	0	1	0.64 (0.12)	0	1	
Post-Treatment	0.51 (0.16)	0	1	0.53 (0.17)	0	1	0.51 (0.16)	0	1	
Follow-Up	0.43 (0.14)	0	1	0.46 (0.18)	0	1	0.46 (0.17)	0	1	
***Alcohol Use* (AUDIT)[e]**										≥ 8
Pre-Treatment	3.00 (3.12)	0	17	**4.91 (4.52)**	0	17	**2.18 (1.75)**	0	6	
Post-Treatment	2.62 (2.87)	0	15	**4.30 (4.43)**	0	15	**2.02 (1.74)**	0	7	
Follow-Up	2.70 (3.47)	0	22	**4.92 (5.38)**	0	22	**1.80 (1.64)**	0	6	
***Cannabis Use* (CUDIT-R)[f]**										≥ 8
Pre-Treatment	2.45 (4.77)	0	23	**7.05 (6.95)**	0	23	**0.72 (1.53)**	0	7	

Post-Treatment	2.01 (4.19)	0	22	**5.91 (6.17)**	0	22	**0.55 (1.50)**	0	7
Follow-Up	2.10 (3.91)	0	19	**5.55 (5.64)**	0	19	**0.75 (1.55)**	0	7

Measured using the [a]Generalized Anxiety Disorder – 7 Item (Spitzer et al., 2006); [b]Patient Health Questionnaire – 9 Item (Kroenke et al., 2001); [c]Patient-Reported Outcomes Measure Information System – Anger Subscale (Pilkonis et al., 2011); [d]Patient-Reported Outcomes Measure Information System – Sleep Disturbance Subscale (Hanish et al., 2017); [e]Parenting Stress Index – Short Form (Barroso et al., 2016); [e]Alcohol Use Disorder Identification Test (Babor et al., 2001); [f]Cannabis Use Disorder Identification Test – Revised (Adamson & Sellman, 2003)
Note: Significant differences between groups are in bold.

Main Effects of Time and ARSU Group on Symptom Outcomes[25]

Changes in depression, anxiety, anger, sleep disturbances, parenting stress, and the mental health composite were examined from T1 to T3 (Table 13). Significant improvements were observed over time across all outcomes: anxiety (b = -2.76, SE = 0.39, $p < .001$), depression (b = -2.60, SE = 0.38, $p < .001$), anger (b = -1.18, SE = 0.25, $p < .001$), sleep disturbance (b = -2.35, SE = 0.45, $p < .001$), parenting stress (b = -0.93, SE = 0.38, $p = .01$), and the mental health composite (b = -0.08, SE = 0.01, $p < .001$).

Intercepts for depression and anxiety symptoms at T1 varied between participants (p's < .001), whereas variability in symptom change did not (p's > .05). In other words, regardless of ARSU group, all mothers in BEAM experienced similar symptom reductions across time but entered BEAM with different mental health symptoms at T1. This further motivates the examination of T0 symptom severity as a moderator of treatment response, as outlined in the protocol (Joyce et al., 2023).

[25] Results did not differ in significance or direction when employment status and breast/chest feeding were included as covariates in the model. In accordance with the principal of parsimony (Vandekerckhove et al., 2014), results are presented from models excluding these variables. See Appendix O for full model results when these two covariates were included.

Table 13. BEAM at-risk substance use group treatment response

	Anxiety Estimate (*SE*)	**Depression Estimate (*SE*)**	**Anger Estimate (*SE*)**	**Sleep Disturbance Estimate (*SE*)**	**Parenting Stress Estimate (*SE*)**	**Mental Health Composite Estimate (*SE*)**
Random effects						
Intercept	**10.81 (2.83)*****	**12.43 (3.23)*****	1.17 (1.21)	**21.98 (4.64)*****	**16.86 (5.81)****	**0.01 (0.0)****
Time	0.54 (0.58)	0.97 (0.74)	**1.17 (0.33)*****	1.31 (0.96)	1.02 (1.23)	**0.00 (0.00)****
Fixed Effects						
Intercept	**15.46 (0.83)*****	**15.48 (0.77)*****	**18.37 (0.47)*****	**30.77 (0.98)*****	**20.53 (0.92)*****	**0.71 (0.02)*****
Time	**-2.76 (0.39)*****	**-2.60 (0.38)*****	**-1.18 (0.25)*****	**-2.35 (0.45)*****	**-0.93 (0.38)***	**-0.08 (0.01)*****
ARSU	1.20 (1.58)	0.87 (1.60)	0.87 (0.90)	1.27 (1.61)	-0.93 (1.59)	0.05 (0.04)
Interaction Effects						
ARSU on time	-0.27 (0.70)	-0.10 (0.66)	-0.58 (0.51)	-0.88 (0.67)	0.73 (0.80)	-0.02 (0.02)

Note: Significant results are bolded; ARSU = at-risk substance use; *SE* = standard error
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Moderation of Enrollment (T0) Symptom Severity

When added to the model as both a covariate and a moderator (time x T0 symptom severity), T0 symptom severity was positively associated with person-level anxiety (b = 15.90, SE = 4.40, $p < .001$), depression (b = 22.27, SE = 3.50, $p < .001$), anger (b = 6.65, SE = 2.74, p = .02), sleep disturbances (b = 16.08, SE = 4.42, $p < .001$), and the mental health composite (b = 0.58, SE = 0.10, $p < .001$), but not parenting stress (b = 6.24, SE = 4.66, p = .18; Table 14).

Both ARSU groups showed significant reductions from T1 to T3 in anxiety (b = -2.81, SE = 0.40, $p < .001$), depression (b = -2.67, SE = 0.41, $p < .001$), anger (b = -1.15, SE = 0.26, $p < .001$), sleep disturbances (b = -2.44, SE = 0.49, $p < .001$), parenting stress (b = -0.88, SE = 0.41, p = .03), and the mental health composite (b = -0.09, SE = 0.01, $p < .001$) from T1 to T3. After accounting for T0 symptom severity, there was no difference in mental health or parenting stress outcomes between ARSU groups. Additionally, T0 symptom severity did not moderate symptom change (time), nor was a T0 symptom severity x ARSU group x time interaction found (p's > .05).

Table 14. At-risk substance use group treatment response, moderated by enrollment (T0) symptom severity

	Anxiety Estimate (*SE*)	**Depression Estimate (*SE*)**	**Anger Estimate (*SE*)**	**Sleep Disturbance Estimate (*SE*)**	**Parenting Stress Estimate (*SE*)**	**Mental Health Composite Estimate (*SE*)**
Random effects						
Intercept	**6.24 (2.90)***	5.46 (2.82)	0.30 (1.05)	**18.07 (4.45)*****	**15.03 (5.95)***	0.00 (0.00)
Time	0.74 (0.58)	**1.45 (0.72)***	**1.16 (0.35)****	1.62 (0.96)	1.08 (1.21)	**0.00 (0.00)*****
Fixed Effects						
Intercept	**15.89 (0.76)*****	**16.01 (0.70)*****	**18.53 (0.47)*****	**31.21 (0.93)*****	**20.68 (0.95)*****	**0.73 (0.02)*****
Time	**-2.81 (0.40)*****	**-2.67 (0.41)*****	**-1.15 (0.26)*****	**-2.44 (0.49)*****	**-0.88 (0.41)***	**-0.09 (0.01)*****
ARSU	-0.23 (1.41)	-0.95 (1.38)	0.36 (0.88)	-0.16 (1.60)	-1.35 (1.67)	0.01 (0.03)
Symptom Severity[a]	**15.90 (4.40)*****	**22.27 (3.50)*****	**6.65 (2.74)***	**16.08 (4.42)*****	6.24 (4.66)	**0.58 (0.10)*****
Interaction Effects						
ARSU on Time	-0.15 (0.67)	0.23 (0.65)	-0.60 (0.51)	-0.67 (0.73)	0.88 (0.86)	-0.01 (0.02)
Symptom Severity on Time	-1.79 (2.40)	-2.93 (2.38)	0.16 (1.51)	-3.18 (2.91)	0.49 (2.07)	-0.08 (0.07)
ARSU * Symptom Severity on Time	0.50 (2.48)	-3.20 (2.47)	-0.90 (1.47)	1.22 (3.69)	-4.72 (2.58)	-0.01 (0.07)

Note: [a]Collected at enrollment; Significant results are bolded; ARSU = at-risk substance use; *SE* = standard error
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Discussion

This was the first study to examine feasibility and symptom trajectories associated with BEAM in mothers with ARSU+ versus ARSU-. Among mothers with ARSU+, BEAM (version 1.0) showed promising indicators of feasibility with respect to treatment adherence, safety, and questionnaire completion time (at T2 and T3). However, several key feasibility benchmarks, including retention, perceived usefulness, and overall questionnaire completion, were not met. Despite these feasibility challenges, mental health (depression, anxiety, sleep, anger) and parenting stress outcomes improved similarly between ARSU groups. These findings contribute to our understanding of eHealth treatments for mental health and parenting skill in a population often excluded from research, i.e., mothers with ARSU+. Insights from this study, alongside findings from other BEAM trials have contributed to the development of BEAM 2.0 – a comprehensive update that includes revised content, enhanced delivery methods, and improved platform infrastructure to better support diverse maternal populations and address previously identified limitations (Simpson et al., 2024). BEAM 2.0 is currently being evaluated in a large-scale trial across Canada (see thebeamprogram.com; Simpson et al., 2024).

Implementation Metrics

Some findings supported the feasibility of BEAM among both ARSU groups, suggesting earlier trial results may extend to mothers with ARSU+ (MacKinnon et al., 2022b; Xie et al., 2023). Both ARSU groups met pre-specified criteria for treatment adherence, safety, and questionnaire completion time at T2 and T3, suggesting similar feasibility. These findings are generally consistent with those reported for mental health treatments targeting parents. For example, MacKinnon et al.'s (2022a) meta-analysis found high treatment adherence (defined as > 50% session attendance or module completion) in most studies. Although there is limited

research on eHealth mental health and parenting skill treatments for mothers with ARSU+, the present findings broadly align with outcomes observed in a review on in-person substance use treatments for mothers of young children (Joyce et al., 2025).

The retention and questionnaire completion rate benchmarks did not meet the conventional feasibility benchmark of 80% for either ARSU group. While some studies involving high-barrier and underserved populations report that retention rates above 60% are often considered acceptable (Barnett et al., 2021; Hilliard et al., 2023; Poole & Isaac, 2001), retention (72.7% [ARSU+] vs. 76.6% [ARSU-]) and questionnaire completion at T3 (71.5% [ARSU+] vs. 76.6% [ARSU-]) remain below the ideal threshold of 80%. Although BEAM did not formally collect data on whether mothers were classified as high-barrier, existing literature suggests mothers with ARSU+ often face systemic barriers to treatment engagement and are considered underserved in clinical contexts (Barnett et al., 2021). In-person substance use treatments for mothers with substance use disorders often report higher retention rates (80.6-91.7%; Joyce et al., 2025), whereas eHealth treatments for parental mental health typically achieve similar retention rates to those observed in this study (MacKinnon et al., 2022a). These suboptimal implementation metrics limit confidence in feasibility conclusions and highlight the need for future trials. For example, future trials should consider implementing evidence-based strategies such as (a) financial incentives for prompt survey completion and increasing compensation over time (Oldham et al., 2024; Parkinson et al., 2019; Watson et al., 2018); (b) gathering secondary contact details to reduce attrition (Beasley et al., 2020); and (c) using technology-enhanced reminders, such as push notifications (Kidd et al., 2023).

Perceived usefulness scores on the MAUQ averaged 3.1 for both ARSU groups, narrowly missing the pre-defined threshold of < 3.0 (Zhou et al., 2019). Technical difficulties encountered

during the trials may have negatively impacted these ratings (Rioux et al., 2022). For example, in the infant trial, 31.3% of Android users reported difficulty accessing BEAMs psychoeducational videos, and 60% of those affected did not watch the videos when offered through YouTube. Across both trials (Joyce et al., 2024; Roos et al., 2024), BEAM was delivered as a minimum viable product – a simplified version of a product with basic features to allow early user testing and refinement (Duc & Abrahamsson, 2016; Münch et al., 2013). Future qualitative research with mothers with ARSU+ and the PAB is critical to identify opportunities to improve BEAM's functionality and perceived usefulness through targeted modifications.

Clinical Outcomes and Promise for ARSU+ Mothers

Symptom reductions were observed over time among mothers in both ARSU groups, both with and without controlling for T0 symptom severity. These findings contribute to preliminary evidence extending prior BEAM research to mothers of young children (aged 6-36 months) with ARSU+. However, because the BEAM versus TAU comparison could not be conducted in the ARSU+ group due to differences in the control conditions and limited power, causal inferences about BEAM's effectiveness in this population cannot be drawn. Instead, results provide early insight into symptom trajectories. The observed symptom trajectories align with meta-analyses demonstrating a small-to-medium effect of eHealth treatments on mental health symptoms in pregnant and postpartum people, including depression (g = 0.29 and 0.37), anxiety (g = 0.26 and 0.53), and parenting stress (g = 0.33; MacKinnon et al., 2022a; Silang et al., 2022). Other meta-analyses have found reductions in substance use for pregnant people receiving eHealth treatments (*OR* = 1.33; Silang et al., 2021); however, substance use outcomes could not be assessed in this study because these data were not collected as part of the BEAM trials. Future adaptations to BEAM should include direct measures of substance use and continue

leveraging partnerships with the PAB to ensure mothers with lived experience of ARSU+ and trusted community agency partners are meaningfully involved.

Limitations and Considerations for Interpretation

Findings should be considered in light of several limitations. First, the impact of BEAM on substance use quantity and frequency could not be examined, as these data were not collected. Future studies should recruit larger samples of mothers with ARSU+ and use consistent, validated measures (e.g., AUDIT, CUDIT-R, Timeline Follow Back; Adamson & Sellman, 2003*;* Babor et al., 2001; Robinson et al., 2014; Sobell & Sobell, 1992) to assess BEAM's impact on substance use. Second, a large percentage of participants reported an annual household income above $90K Canadian Dollars (43.4%) and having at least a high school diploma (93.6%), which may limit generalizability to mothers of lower socioeconomic status (Emery et al., 2023). Despite this, participating mothers were generally representative of the Canadian population in terms of household income and marital status (Statistics Canada, 2022b; 2025). Education levels were slightly higher (93.6% with a high school diploma or higher in this study versus 86.3% in Canada), while the proportion identifying as White/Caucasian was slightly lower (62.7% in this study versus 69.8% in Canada; Statistics Canada, 2017; 2022a). Third, technical difficulties affected access to BEAM's psychoeducational videos – a core component of the program that delivers the UP (Barlow et al., 2017; Farchione et al., 2012) and emotion-focused parenting strategies (Havighurst et al., 2020). As such, some mothers may not have received adequate exposure to BEAM's therapeutic content. To address this, BEAM 2.0 was developed to improve cross-platform functionality and incorporate feedback from prior iterations (MacKinnon et al., 2022b; Xie et al., 2023), patient-partners, and community collaborators (Simpson et al., 2024). Finally, both trials were conducted during the COVID-19 pandemic.

Observed symptom reductions may therefore reflect the broader reduction in mental health symptoms and pandemic-related stressors over time (Reutter et al., 2024). Further RCTs are needed to determine BEAM's effectiveness in post-pandemic contexts.

Strengths and Opportunities for Future Adaptation

Several notable strengths should be highlighted. This was the first study to examine the feasibility and symptom trajectories associated with BEAM among mothers with ARSU+, a population that has historically faced limited access to acceptable, evidence-based mental health and parenting treatments (Barnett et al., 2021; Joyce et al., 2025; Milligan et al., 2010; Neo et al., 2021; Niccols et al., 2012). Although we could not compare outcomes among mothers with ARSU+ in BEAM versus TAU – precluding conclusions about treatment effectiveness – this study offers early insight into the feasibility and potential relevance of BEAM for this underserved group. BEAM was offered with no treatment-specific costs to participants (assuming existing access to internet and a cell phone) and was designed to overcome common structural barriers to treatment such as cost, transportation, and scheduling conflicts (Ingoldsby, 2010). Importantly, BEAM incorporated lay mental health workers (peer and parent coaches), aligning with global recommendations (Atif et al., 2015).

Future Directions: Tailoring BEAM to Address Substance Use

Although BEAM was not originally designed to treat substance use, future iterations could incorporate strategies to better support the needs of mothers with ARSU+, as identified by findings from this study and the broader literature. By embedding evidence-based and scalable adaptations, BEAM may offer a promising avenue to address key treatment gaps for mothers with ARSU+ if effectiveness is established in future trials.

1. *Employment Support:* Mothers with ARSU+ were more likely to be unemployed than their ARSU- counterparts, aligning with broader research linking substance use and economic instability (Centers for Disease Control and Prevention, 2023; Nolte-Troha et al., 2023). Unfortunately, employment status was not measured at follow-up, limiting our ability to assess whether participation in BEAM was associated with changes in employment. Nonetheless, this disparity highlights an area of need. Future iterations of BEAM may benefit from incorporating occupational skill building (e.g., interviewing skills, job search support, employment readiness modules) to address socioeconomic stressors. Such additions could help align BEAM with components commonly included in comprehensive substance use disorder treatments for mothers of young children (Joyce et al., 2025).
2. *Lactation Psychoeducation*: A greater proportion of mothers with ARSU+ (61.5%) reported breast/chest feeding compared to ARSU- mothers (29.3%). While this study could not evaluate the impact of BEAM on lactation behaviors, these differences suggest that future adaptions may be needed. The benefits of human milk for infants are well documented (Dietary Guidelines Advisory Committee Members, 2025; Meek & Noble, 2022; United States Centers for Disease Control and Prevention, 2023; World Health Organization, n.d.), however, substance use during lactation poses safety concerns. For instance, alcohol concentrations in breast/chest milk closely align with maternal blood alcohol levels, prompting recommendations to restrict alcohol consumption while lactating (Meek & Noble, 2022; Pham et al., 2020). Likewise, cannabis use during lactation is discouraged because of concerns about potential effects on infant neurodevelopment; however, existing evidence is limited (Meek & Noble, 2022). While

cannabinoids are excreted in human milk (Bertrand et al., 2018), the extent of infant exposure and clinical consequences are unclear (National Library of Medicine, 2025). Future BEAM iterations should consider including psychoeducation on the risks of alcohol and cannabis use during lactation within a harm reduction framework. Content should be co-designed with mothers who have lived experience of ARSU+, ensuring it is empathetic, non-judgemental, and acknowledges the motivations behind substance use (e.g., stress, sleep difficulties, emotion regulation; Nathoo et al., 2021). This approach may foster more meaningful engagement and support informed decision making.

3. *Evidence-Based Substance Use Treatments*: To more directly support reductions in substance use, future iterations of BEAM could integrate components drawn from established substance use disorder treatments such as motivational interviewing (Smedslund et al., 2011), cognitive-behavioral strategies to address cravings and relapse prevention (Larimer et al., 2003; McHugh et al., 2010), and contingency management (Kock et al., 2023). These adaptations may help enhance BEAM's relevance and responsiveness to the needs of mothers with ARSU+. Future evaluation would be required to assess whether these adaptions enhance outcomes beyond those observed in the current study.
4. *Culturally Grounded and Trauma-Informed Practices*: Future adaptations should include trauma-informed principles and culturally grounded practices to ensure BEAM is responsive to diverse needs, as BEAM was not originally designed for mothers with ARSU+. While this study did not directly assess whether cultural needs were unmet, the absence of culturally tailored content specific for mothers with ARSU+ suggests important gaps in alignment with best practices. Co-developing content with community

partners, Indigenous Knowledge Keepers, and mothers with lived experience of ARSU+ can help ensure future iterations of BEAM are culturally relevant, responsive, and meet the unique needs of mothers with ARSU+. These efforts may improve engagement, perceived safety, and cultural relevance, important precursors to effective care.

5. *Measurement of Substance Use Outcomes*: To evaluate BEAM's effectiveness on substance use, future trials should include standardized, validated measures of substance use quantity and/or frequency to facilitate cross-study comparability (e.g., the Timeline Follow Back; Robinson et al., 2014; Sobell & Sobell, 1992).
6. *Qualitative Research and Parent Advisory Boards (PAB)*: Qualitative research should be conducted to ensure that future iterations of BEAM are grounded in the lived experiences of mothers with ARSU+. Interviews and focus groups could help glean valuable insight into priorities, preferences, and perceived barriers to treatment accessibility. These findings could also inform adaptations to treatment content, ensuring it is well accepted and relevant to this population. Additionally, establishing a PAB composed of mothers with lived experience of ARSU+ will support the co-development of treatment content, provide ongoing feedback throughout treatment adaptations, and help ensure cultural safety and relevance.

Conclusions

This study provides preliminary evidence on the feasibility and promise of delivering BEAM to mothers with ARSU+. Reductions were observed over time in depression, anxiety, anger, sleep disturbances, a mental health composite, and parenting stress. Improvements in mental health and parenting stress outcomes were similar between ARSU+ and ARSU- mothers, even after controlling for enrollment symptom severity. While these findings suggest BEAM

may be acceptable and beneficial for mothers with ARSU+, it is important to note that a comparison between BEAM and TAU within the ARSU+ group could not be conducted due to insufficient power. Causal inferences about BEAMs effectiveness for ARSU+ mothers could not be made. To improve feasibility for this population, future adaptions should focus on improving retention rate, questionnaire completion, and perceived usefulness. Overall, BEAM is a scalable, evidence-based treatment that holds promise, pending further evaluation, to address unmet mental health and parenting needs among mothers with ARSU+ in Canada.

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CHAPTER FIVE: General Discussion

This dissertation aimed to address gaps in our knowledge on the feasibility and effectiveness of single-focus eHealth treatments for individuals with mental health concerns and/or at-risk substance use (ARSU). This was approached through two complementary studies: a systematic review and meta-analysis examining the effects of eHealth treatments on alcohol and cannabis use outcomes (manuscript 1), and a secondary data analysis evaluating an eHealth treatment for mental health and parenting stress among mothers with co-occurring mental health concerns and ARSU (ARSU+) versus those with mental health concerns but not ARSU (ARSU-; manuscript 2). The overarching aim was to examine whether a single-focus eHealth treatment – originally developed for either mental health or substance use – may provide benefit to individuals with complex and co-occurring needs, such as mothers of young children with ARSU+.

Integration of Findings Across Manuscripts

The two manuscripts presented in this dissertation addressed complementary but distinct questions related to eHealth treatment for mental health and ARSU. This section integrates findings across both studies to examine areas of convergence, divergence, and combined implications.

Findings from manuscript 1 indicated that eHealth treatments were associated with small, but significant, reductions in alcohol use at post-treatment and cannabis use at follow-up, consistent with prior meta-analyses and umbrella reviews showing small-to-moderate effects (Boumparis et al., 2019; Cadigan et al., 2015; Carey et al., 2009, 2012; Dedert et al., 2015; Donoghue et al., 2014; Hoch et al., 2016; Khadjesari et al., 2011; Olmos et al., 2018; Riper et al., 2011, 2014; Rooke et al., 2010; Sundström et al., 2017; Tait et al., 2013; Tait & Christensen,

2010; Webb et al., 2010). Manuscript 1 adds a layer of complexity by examining the impact of participant-, treatment-, and study-level moderators. Larger treatment effects were identified for studies with an ARSU inclusion requirement, an older sample mean age, non-college/university participants, those that did not include an intention-to-treat analysis, and those published outside of North America. Specific treatment components, including motivational interviewing, cognitive strategies, relapse prevention, and emotional regulation and mental health support, were also associated with improved alcohol use outcomes. These results point toward the importance of delivering tailored eHealth treatments that are responsive to the characteristics, motivations, and needs of the populations they aim to serve – an approach consistent with precision-based treatment models that emphasize providing the right treatment to the right individual (Deisenhofer et al., 2024).

Manuscript 2 addressed a key gap by examining the feasibility and symptom trajectories associated with an existing eHealth treatment (i.e., Building Emotional Awareness and Mental health [BEAM]) originally developed to address mental health and parenting stress. Despite BEAM not including ARSU-specific content, mothers with ARSU+ showed comparable implementation metrics and symptom trajectories (mental health and parenting stress) relative to mothers with ARSU-. These findings suggest that mothers with ARSU+ may experience potential benefits from a single-focus mental health and parenting eHealth treatment, particularly in contexts where access to integrated or in-person treatment is limited. Similarly, findings indicate that mothers with ARSU+ may benefit from access to employment resources and breast/chest feeding supports. Future research is needed to clarify BEAM's impact on substance use outcomes and to examine whether integrating substance use-specific treatment components may more comprehensively address the complex needs of mothers with ARSU+.

Collectively, the findings from these two manuscripts offer complementary insight into how eHealth treatments can serve individuals with ARSU+. While manuscript 1 identified small but significant effects of eHealth treatments on alcohol and cannabis use (particularly when treatments used motivational interviewing, cognitive strategies, relapse prevention, and emotional regulation and mental health supports), manuscript 2 provided preliminary knowledge that a single-focused mental health and parenting treatment may be feasible and acceptable for mothers with ARSU+, even without ARSU-specific content, and may be associated with favorable symptom trajectories in mental health and parenting stress outcomes. Although integrated treatments remain the gold standard, they are not always accessible due to common barriers (Kelly et al., 2012; Mueser & Gingerich, 2013; Torrens et al., 2012). Taken together, these findings raise the possibility that single-focus, flexible eHealth treatments could offer a pragmatic and inclusive option in some contexts – especially when they include evidence-based treatment components. They highlight the value of both targeted and transdiagnostic eHealth treatments, and underscore the relevance of stepped-care and adaptable models in future eHealth treatment systems.

Theoretical and Clinical Implications

Applying the Capability, Opportunity, and Motivation-Behavior (COM-B) Model to eHealth

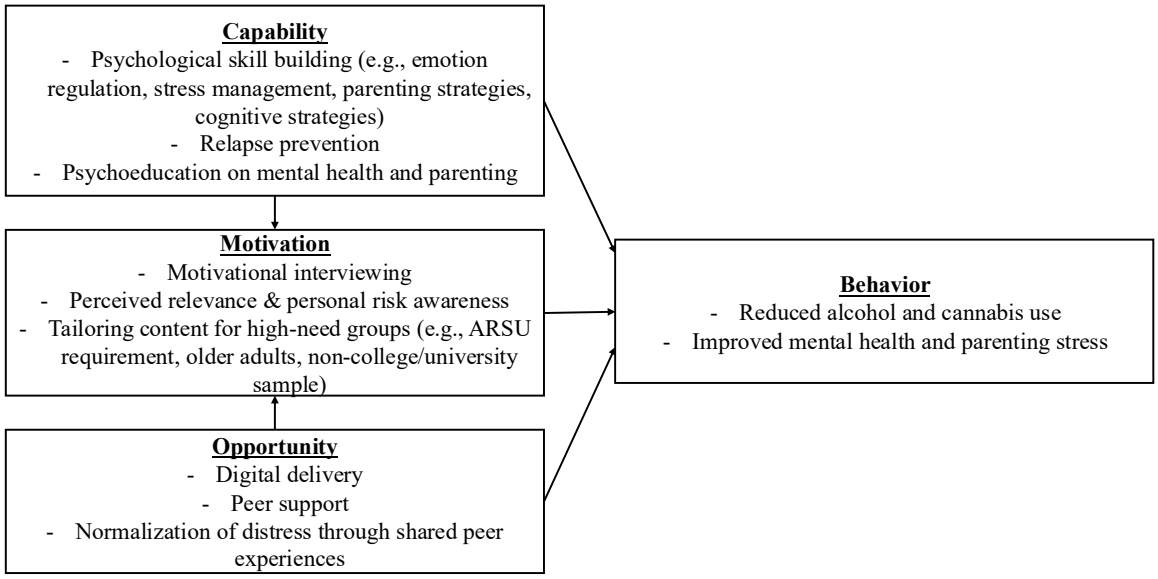
The COM-B model provides a valuable conceptual lens for understanding the mechanism by which eHealth treatments may influence behavior change. According to the model, three conditions must be present for behavior change to occur, that is, the individual has the capability, opportunity, and motivation to change (Michie et al., 2011). Findings from both manuscripts align with each domain of the COM-B model and provides insight into which treatment components may be most impactful.

In manuscript 1, treatment components including emotional regulation and mental health support, cognitive strategies, and relapse prevention were associated with greater reductions in alcohol use, suggesting these components may enhance psychological *capability* by increasing one's ability to manage cravings, distress, and risky situations. Motivational interviewing supported the *motivation* domain, influencing readiness and willingness to change. Moderation analyses also found larger effects in studies with an ARSU inclusion requirement. It is possible that these individuals, by virtue of recognizing the severity of their substance use and actively seeking treatment, may be more motivated to engage in eHealth treatment (i.e., in the action stage of change; del Rio Szupszynski & de Ávila, 2021). eHealth treatments were also more effective in samples of older adults and with a non-college/university sample, suggesting eHealth treatments, at least at present, may be better tailored to the needs and preferences of these specific groups. Finally, the inherent digital delivery of eHealth treatments likely reduces barriers to accessing in-person treatment (e.g., travel, cost, scheduling constraints), thereby improving the *opportunity* domain (Farhoudian et al., 2022; Wang et al., 2024).

Findings from manuscript 2 suggest that BEAM may support behavior change among mothers with ARSU+. Findings suggest BEAM provides sufficient *capability* through skill building (via emotion regulation, parenting strategies, and stress management), *opportunity* (via its digital delivery format), and *motivation* (via peer support and the normalization of distress through shared peer experiences) to allow for behavior change. The results also suggested that tailoring BEAM with content relevant to the lived experiences of mothers with ARSU+, such as employment resources and breast/chest feeding support, may further strengthen opportunity and capability in future iterations of BEAM.

Taken together, the COM-B model offers an integrative framework to interpret how eHealth treatments function across specific populations and treatment components. This model could also help guide future eHealth treatment development. Figure 9 illustrates how treatment components from both manuscripts map onto the three COM-B domains.

Figure 9. Applying the Capability, Opportunity, and Motivation - Behavior (COM-B) Model to eHealth treatments: A conceptual framework from two studies



Broader Conceptual Implications for eHealth Treatment Development

This dissertation contributes to evolving conceptualizations of how eHealth treatments can support individuals with ARSU+. While integrated treatments remain the gold standard (Kelly et al., 2012; Mueser & Gingerich, 2013; Torrens et al., 2012), they are often inaccessible – particularly for underserved or marginalized populations such as mothers with young children (Mental Health Commission of Canada & Canadian Centre on Substance Use and Addiction, 2023; Minkoff & Covell, 2022). Findings from this dissertation suggest that individuals with co-

occurring concerns may still experience symptom improvement through participation in single-focus treatments. Similar results have been reported in RCTs examining co-occurring post-traumatic stress and alcohol use disorder, where standalone treatments (i.e., Cognitive Processing Therapy or Relapse Prevention) were associated with improvements in post-traumatic stress and alcohol use outcomes (Simpson et al., 2022). As such, clinicians might consider referring individuals with co-occurring concerns to single-focused eHealth treatments, particularly when access to integrated or in-person treatment is limited. These findings may support efforts to develop more inclusive approaches to eHealth treatment and referral practices.

These findings also emphasize the need for clinical trials evaluating eHealth treatments to accommodate clinical complexity through broad inclusion rather than exclusion. Mothers with ARSU+ often face systemic barriers to accessing traditional in-person treatment, including lack of childcare, stigma, and fear of involvement with child and family services (Farhoudian et al., 2022; Poole & Isaac, 2001). Mental health-focused eHealth treatments like BEAM may offer a scalable and cost-effective alternative for this population (Puleo et al., 2021), even in the absence of ARSU-specific content. To maximize their impact, eHealth treatments should include flexible yet structured, evidence-based core components (e.g., emotion regulation, peer support, and parenting strategies) that are broadly applicable across clinical presentations, while offering optional modules (e.g., relapse prevention, employment resources, breast/chest feeding supports) tailored to user specific needs to enhance relevance and engagement. This flexible approach is consistent with trauma-informed, equity-focused, and access-oriented principles in eHealth delivery (Abdulai et al., 2023; Cheng et al., 2020). By offering adaptability and reducing access barriers, eHealth treatments may be able to more effectively reach individuals who might otherwise remain underserved.

Clinical Implications for the Practice of Clinical Psychology

Findings hold practical implications for clinical psychologists working in community and perinatal mental health settings. These studies highlight the potential of flexible, scalable eHealth treatments to support individuals facing barriers to traditional in-person treatment, without requiring diagnosis- or symptom-specific treatment models. Together, the two studies offer complementary insight into how single-focus treatments may function in psychological practice. While integrated treatments remain the gold standard for individuals with ARSU+ (Kelly et al., 2012; Mueser & Gingerich, 2013; Torrens et al., 2012), they are often unavailable due in part to limited resources, system fragmentation, and access barriers (Padwa et al., 2015). In these contexts, single-focus treatments may still offer symptom-related benefits, particularly when they include foundational strategies such as motivational interviewing, cognitive strategies, relapse prevention, and emotion regulation and mental health support. In contexts where integrated services are unavailable, psychologists may consider offering single-focus treatments that include evidence-based components and are delivered through formats that are flexible and responsive to their patients' needs. This supports movement away from rigid exclusionary criteria and toward process-based approaches to treatment that prioritize patient needs, treatment fit, and engagement. In perinatal mental health contexts, this flexibility can be especially valuable, as mothers often face intersecting barriers to accessing treatment. eHealth treatments may therefore offer one promising avenue to reduce these barriers by extending the reach of psychological treatment and serving as an entry point into the broader mental health system. Taken together, findings highlight the potential value of flexible and inclusive treatment approaches, especially when ideal or specialized treatments are unavailable.

Limitations

Several limitations should be acknowledged for this dissertation. Across both studies, the ability to examine outcomes among individuals with ARSU+ was limited due to a small sample size. In manuscript 1, most trials did not report on co-occurring mental health diagnoses, and as such, this variable could not be examined as a moderator of treatment effect. In manuscript 2, while between-group ARSU differences were examined, substance use outcomes were not measured and BEAM was not developed to evaluate substance use. Due to small group sizes, effect size estimates specific to those with ARSU+ could not be reliably estimated. As such, conclusions about the impact of eHealth treatments on ARSU+ should be interpreted with caution. Additionally, this dissertation did not evaluate or compare treatment effects to other treatments commonly used for ARSU+ (e.g., pharmacological treatments). As such, no conclusions can be drawn regarding their relative effectiveness. Second, generalizability may be a concern. Participants across both manuscripts were able and willing to engage with eHealth treatments, which may have excluded individuals with more severe symptoms, lower mental health literacy, or limited internet access (Harris et al., 2021; Tay et al., 2018). In manuscript 2, it is unclear whether the proportion of mothers with ARSU+ reflects population-level prevalence rates during the COVID-19 pandemic, as limited research is available on this topic; this may further limit generalizability. Although eHealth treatments are frequently proposed as an option to reduce barriers, inequalities in digital poverty and geographic isolation may continue to limit reach. Future eHealth treatment research should consider hybrid delivery, collaboration with community-based organizations, and technology subsidies to mitigate potential access barriers. Third, there was limited ability to assess several eHealth treatment moderators due to inconsistent reporting (e.g., parental and co-occurring mental health status) across studies

included in manuscript 1. In manuscript 2, the small sample size of the ARSU+ group (n = 33) may have impacted statistical power to detect meaningful differences in symptom outcomes. Finally, while the COM-B model (Michie et al., 2011) was used to conceptually interpret findings in this dissertation, it was not a guiding framework during study design or data collection. As such, its application should be viewed as a post-hoc, interpretive tool rather than an empirically tested framework. Collectively, these limitations point to the constraints inherent in meta-analyses and secondary data analyses. While this dissertation provides a strong empirical and theoretical foundation, further research is needed to evaluate the effectiveness of eHealth treatments in individuals with ARSU+.

Future Directions

Building on the findings and limitations of this dissertation, several future research directions are proposed. First, there is a need for more inclusive and methodologically rigorous RCTs of eHealth treatments. Many studies included here lacked sufficient reporting of key sociodemographics and clinical characteristics which limited moderator analyses. Future RCTs should prioritize transparency (e.g., pre-registration) and inclusion of key demographic and clinical characteristics. Second, future eHealth treatments for those with ARSU+ should be developed using core and tailored treatment components. Findings indicate treatment components like emotional regulation and mental health support, psychoeducation, peer support, and parenting strategies may offer broad treatment benefits. Expanding eHealth treatments using optional modules, such as relapse prevention, employment resources, and breast/chest feeding supports, may also improve relevance, engagement, and symptom outcomes across users without requiring separate treatments for each presenting concern. I am currently developing a grant proposal to co-design and pilot these substance use-specific modules in partnership with mothers

with lived experience of ARSU+. Third, future studies should incorporate standardized measures of substance use outcomes (e.g., quantity, frequency, severity) to allow for comparability between studies (Core Outcome Measures in Effectiveness Trials [COMET] Initiative, n.d.) and evaluate whether BEAM participation influences substance use over time. Finally, there is a growing need to understand how eHealth treatments can be scaled and sustained within existing healthcare systems. Implementation research should focus on how eHealth treatments can be embedded within provincial and national maternal mental health strategies. Strategic partnerships with clinicians, community agencies, policymakers, and people with lived experience – such as those involved in the Manitoba Perinatal Mental Health Hub – will help ensure treatments are embedded into routine care. These future directions reflect opportunities to enhance the reach, relevance, and impact of eHealth treatments for underserved populations – particularly mothers navigating complex mental health concerns and ARSU during early motherhood.

Knowledge Translation

This dissertation was guided by a patient-oriented and equity-focused approach, with the goal of generating knowledge that is meaningful and actionable for individuals with lived experience of ARSU+, as well as clinicians, treatment developers, and policymakers alike. Consistent with the Canadian Institutes of Health Research (CIHR) approach to integrated knowledge translation (Canadian Institutes of Health Research, 2015), this dissertation aimed to ensure findings are accessible and useful to those directly affected by existing treatment gaps.

Engagement of Knowledge Users

Knowledge users were actively engaged throughout the dissertation process. As part of the CIHR-funded Mental Health in the Early Years (MHitEY) trial (Principal Investigator: Dr.

Leslie Roos), a hybrid effectiveness-implementation evaluation of BEAM (Simpson et al., 2024), I contributed to the project's pre-implementation phase, including participation in the MHitEY planning retreat. This retreat brought together stakeholders across research, policy, and community sectors including parent partners, academic researchers, trainees, clinicians, and representatives from organizations like Family Dynamics, Acorn Family Place, the United Way, the Manitoba Ministry of Mental Health and Community Wellness, and the Public Health Agency of Canada. Additionally, ongoing input was obtained from the Parent Advisory Board (PAB), a group of mothers with lived experience of mental health concerns and/or ARSU. The PAB provided feedback on knowledge translation strategies, including how to ensure cultural responsiveness through language, framing, and dissemination formats. Their insights also informed broader implementation planning to ensure BEAM and its findings would be accessible and relevant for diverse populations. This collaborative and interdisciplinary partnership helped shape the knowledge dissemination efforts of this dissertation.

Planned Clinical Integration and Program Expansion

Informed by dissertation findings, I am currently developing a new grant application to expand BEAM for mothers with ARSU+. Planned additions include modules on relapse prevention, motivational interviewing, cognitive strategies, employment resources, and breast/chest feeding supports. These modules will be co-developed alongside mothers with lived experience and tested through partnerships established via the MHitEY initiative and a planned qualitative component to explore mothers' experiences, perceived relevance, and implementation feedback.

Advancing Equitable Access

Knowledge translation efforts will target community-based systems of care that support marginalized mothers. I will develop infographics and aim to present findings at community organizations such as the Mothering Project. All materials will focus on practical application of the study results, aiming to support front-line staff, improve referral practices, and reduce access barriers. These efforts will involve the use of public-facing dissemination strategies (e.g., *The Conversation Canada*, plain language summaries, and community conference presentations) described below, to ensure equitable access to research findings across clinical and non-clinical settings.

Policy and System-Level Opportunities

I am also in the process of co-writing a grant to support the Manitoba Perinatal Mental Health Hub. This initiative aims to improve province-wide access to coordinated, trauma-informed treatment for mothers with mental health concerns and/or ARSU. This dissertation found that mothers with ARSU+ and ARSU- experienced similar improvements in mental health and parenting outcomes. These findings highlight the feasibility and potential value of integrating evidence-based eHealth options within provincial treatment delivery frameworks.

Dissemination Strategy

A multi-pronged knowledge mobilization strategy is underway:

1. *Academic dissemination*: Each study will be submitted to open-access, peer-reviewed journals and presented at major academic conferences such as the Canadian Psychological Association's Annual Conference. To increase early access and transparency, both manuscripts will be pre-printed on PsyARXiv.
2. *Implementation partnerships:* Opportunities will be explored to share findings through knowledge translation-focused networks such as SPOR SUPPORT Units and the Centre

for Healthcare Innovation. Where appropriate, preliminary discussions or partnerships may focus on co-developing implementation tools and resources that support the integration of BEAM and related eHealth treatments into clinical and community care pathways.

3. *Public communication & public-facing materials*: To improve accessibility and engagement with non-academic audiences, infographics, visual summaries, and plain language summaries will be co-developed with the PAB of the Hearts and Minds Laboratory and shared via social media, newsletters, and platforms such as *The Conversation Canada.*
4. *Community engagement*: Results will be explored in partnership with community groups such as The Mothering Project, Family Dynamics, and Acorn Family Place.
5. *Policy engagement*: Findings are being shared with policymakers and health system leaders through tailored proposals developed within the Manitoba Perinatal Mental Health Hub. Dissertation findings are informing the Hub's plan for service delivery and advocacy priorities. In addition, I plan to disseminate results through pre-established partnerships with the Partnering for Research Innovation in Mental Health (PRIME) theme and Children's Hospital Research Institute of Manitoba (CHRIM). I also intend to present insights at multi-stakeholder knowledge exchange events involving representatives from provincial ministries, public health agencies, and national coalitions (e.g., Canadian Perinatal Mental Health Collaborative) to support evidence-informed policy development in maternal mental health and eHealth integration.

Conclusion

This dissertation contributes to existing research focused on improving the accessibility, inclusivity, and scalability of mental health and substance use treatments. It draws on two complementary studies: a systematic review and meta-analysis of eHealth treatments for alcohol and cannabis use (manuscript 1), and a secondary data analysis of a maternal eHealth treatment for mental health and parenting stress (manuscript 2). Findings from the meta-analysis showed that eHealth treatments were associated with small but significant reductions in alcohol and cannabis use (manuscript 1), and that BEAM, a mental health-focused eHealth treatment, shows promise in benefiting mothers with ARSU+ (manuscript 2). By examining mothers with ARSU+, a group often excluded from research, this work contributes to advancing more inclusive approaches to treatment development, less exclusionary pathways to treatment, and implementation strategies grounded in accessibility and equity. Building on these preliminary findings, funding is being sought to expand BEAM to include modules, such as relapse prevention. This work is also directly informing an ongoing funding proposal to support the development of the Manitoba Perinatal Mental Health Hub, which aims to expand Manitoba-wide access to coordinated, trauma-informed, and culturally responsive perinatal mental health and substance use treatments. Collectively, this dissertation helps lay the groundwork for future research, clinical innovation, and system-level integration of eHealth treatments that respond to the realities of complex and stigmatized populations.

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Appendix A
Meta-Analysis and Systematic Review Keywords

(eHealth or e-Health or internet or online or on-line or web-based or "web based" or smart-phone or smartphone or "smart phone" or mobile or "mobile phone" or mobile-phone or "mobile health" or mHealth or app-based or computer or "computer systems" or computers or "cell phone" or cell-phone or cellphone or SMS or text-based or "text based" or website or "social media" or web-based or "web based" or digital or self-directed or "self directed" or technology-assisted or "technology assisted" or self-help or "self help" or self-guided or "self guided" or telecommunications or telecommunication)

AND

(RCT or "randomized controlled trial" or "controlled clinical trial" or "clinical trial" or efficacy or effectiveness or "random allocation" or trial)

AND

("substance use" or externalizing or "substance-related disorder" or "substance related disorder" or "substance abuse" or substance-abuse or "substance dependence" or substance-dependence or addiction or addict or "drug abuse" or drug-abuse or "drug dependence" or drug-dependence or "alcohol abuse" or alcohol-abuse or "alcohol dependence" or alcohol-dependence or alcoholism or alcoholic or cannabis or marijuana or marihuana or THC or tetrahydrocannabinol)

Appendix B

Alcohol and Cannabis Use Outcomes Across Studies

Alcohol and cannabis use outcomes were summarized across included studies using frequency statistics.

Substance Use Outcomes

See below for alcohol and cannabis use quantity/frequency outcomes used across included studies.

Alcohol Use.

Quantity. Measures of alcohol use quantity included amount of alcohol used, amount of alcohol used per drinking day/occasion, amount of alcohol used per week, and peak alcohol use. Quantity was measured using standard drinks, units, grams, and undefined quantities. Assessment timeframes ranged from the past 7 days to 6 months.

Frequency. Alcohol use frequency was measured using number of days abstinent, days used, days used per drinking day, days used per week, times used, and binge/heavy drinking. Binge/heavy drinking definitions varied substantially across studies. Assessment timeframes ranged from past 7 days to 6 months.

Cannabis Use.

Quantity. Cannabis use quantity was measured using grams and standard joints, assessment timeframes ranged from past 7 to 30 days, and methods of use included smoking, vaped, dabbed, and edibles (when reported).

Frequency. Measures of cannabis use frequency included number of days abstinent, days used, times used, and hours high. When reported, methods of use included smoking, vaped, dabbed, and edibles. Assessment timeframes ranged from the past 7 to 90 days.

Substance Use Outcomes Used Across Studies

Substance	Validated Measures Used	Outcomes
Cannabis	*1. Timeline Follow Back (TLFB)* *2. Youth Risk Behavior Survey* *3. Cannabis Use Disorder Identification Test – Revised (CUDIT-R)* *4. The Alcohol, Smoking, and Substance Involvement Screening Test (ASSIST)* *5. Protective Behavioral Strategies for Marijuana* *6. Cannabis Engagement Assessment*	***Quantity*** - Amount of cannabis used in past 7 days (in standard joints, grams) - Amount of cannabis used in past 30 days (in grams) - Amount of cannabis used in past month (in standard joints) - Amount of cannabis smoked in past 30 days (in grams) - Amount of cannabis vaped in past 30 days (in grams) - Amount of cannabis dabbed in past 30 days (in grams) - Amount of cannabis edibles used in past 30 days (in grams) ***Frequency*** *Abstinence* • # of days without cannabis use in past 7 days *Days Used* • # of days used cannabis in past 7 days • # of days high in past 7 days • # of days used cannabis in past 14 days • # of days used cannabis in past 30 days • # of days used cannabis in past month • # of weeks high in past month • # of days used cannabis in past 90 days • # of days smoked cannabis in past 30 days • # of days vaped cannabis in past 30 days • # of days dabbed cannabis in past 30 days • # of days using cannabis edibles in past 30 days *Times Used* • # of times used cannabis in past 30 days • # of times smoked cannabis in past 30 days • # of times vaped cannabis in past 30 days • # of times dabbed cannabis in past 30 days • # of times used cannabis edibles in past 30 days • # of hours high per cannabis using day

		• # of periods high in past week *Miscellaneous* • Frequency[1] of cannabis use in unknown timeframe
Alcohol	*1. Timeline Follow Back (TLFB)* *2. Daily Drinking Questionnaire (DDQ)* *3. Daily Drinking Questionnaire – Revised (DDQ-R)* *4. Alcohol Use Disorder Identification Test – Consumption Subscale (AUDIT-C)* *5. Alcohol Use Disorder Identification Test (AUDIT)* *6. Quantity, Frequency, Max Measure* *7. Past Week Alcohol Consumption (TOT-AL)* *8. Brief Drinker's Profile* *9. Quantity/Frequency Index* *10. Quantity/Frequency/Peak Alcohol Use Index* *11. Quantity/Frequency – 30 day (QFV-30)* *12. Alcohol Consumption Index (ACI)* *13. Alcohol Weekly Recall – Dutch Version*	***Quantity*** *Amount of Alcohol Used* • Amount of alcohol used in past 7 days (in standard drinks, units, grams, undefined) • Amount of alcohol used in past 14 days (in standard drinks) • Amount of alcohol used in past 28 days (in standard drinks, grams) • Amount of alcohol used in past 30 days (in standard drinks) *Amount of Alcohol Used Per Drinking Day/Occasion* • Amount of alcohol used on *last drinking occasion* in unknown timeframe • Amount of alcohol used *before last drinking and driving episode* (in standard drinks) • Amount of alcohol used *per drinking day* in past 7 days (in standard drinks, units, unspecified) • Amount of alcohol used *per drinking day* in past 14 days (in standard drinks) • Amount of alcohol used *per drinking day* in past 28 days (in standard drinks) • Amount of alcohol used *per drinking day* in past 30 days (in standard drinks) • Amount of alcohol used when *tailgating* in past 30 days (in standard drinks) • Amount of alcohol used *per drinking day* in past month (in standard drinks, undefined) • Amount of alcohol used in t*wo heavy drinking episodes* in past month (in standard drinks) • Amount of alcohol used *per drinking day* in past 3 months (in standard drinks, units) • Amount of alcohol used *per drinking day* in past 90 days (in standard drinks) *Amount of Alcohol Used Per Week* • Amount of alcohol used *per week* in unknown timeframe (in standard drinks)

14. Beverage Intake Questionnaire

15. Quantity/Frequency Scale

- Amount of alcohol used *per week* in past 14 days (in standard drinks)
- Amount of alcohol used *per week* in past 28 days (in standard drinks)
- Amount of alcohol used *per week* in past 30 days (in standard drinks)
- Amount of alcohol used *per week* in past month (in standard drinks, grams, unspecified)
- Amount of alcohol used *per week* in past 2 months (in standard drinks)
- Amount of alcohol used *per week* in past 90 days (in standard drinks)
- Amount of alcohol used *per week* in past 3 months (in standard drinks)
- Amount of alcohol used *per week* in the past 6 months (in standard drinks)

Peak Alcohol Use

- Peak alcohol use on one day in the past 7 days (in standard drinks, units, unspecified)
- Peak alcohol use on one day in the past 14 days (in standard drinks)
- Peak alcohol used on one day in the past 28 days (in standard drinks)
- Peak alcohol used on one day in the past month (in standard drinks, undefined)
- Peak alcohol used on one day in the past 2 months (in standard drinks)
- Peak alcohol used on one day in the past 6 months (in standard drinks)

Frequency

Abstinence

- # of days abstinent from alcohol in past 7 days
- # of days abstinent from alcohol in past 30 days
- # of days abstinent from alcohol in past 3 months
- # of days abstinent from alcohol in past 6 months

Days Used

- # of days alcohol used in past 7 days
- # of days drinking above recommended limits in past 7 days
- # of days alcohol used in past 14 days
- # of days alcohol used in past 28 days

- # of days alcohol used in past 30 days
- # of days alcohol used in past month
- # of days alcohol used in past 90 days
- # of days alcohol used in past 3 months
- # of days 3+ alcohol drinks were used before driving in past 3 months

Days Used Per Drinking Day

- # of days alcohol used *per drinking day* in past 30 days

Days Used Per Week

- # of days alcohol used *per week* in unknown timeframe
- # of days alcohol used *per week* in past 28 days
- # of days alcohol used *per week* in past 30 days

Times Used

- # of times alcohol used in past month
- # of times alcohol used to intoxication in past 30 days

Miscellaneous

- Frequency[1] of alcohol used in unknown timeframe

Binge/Heavy Drinking[2]

- # of binge/heavy drinking days in past 7 days
- # of binge/heavy drinking days in past 14 days
- # of binge/heavy drinking days in past 28 days
- # of binge/heavy drinking days in past 30 days
- # of binge/heavy drinking days in past month
- # of binge/heavy drinking days in past 3 months
- # of binge/heavy drinking days in past 84 days
- # of binge/heavy drinking days in past 90 days
- # of heavy drinking days in past week, average week, past month and average month (composite score)

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[1]Frequency was not defined

[2] Binge drinking was defined differently across studies and included the following number of drinks: 4+ Men (M)/3+ Women (W) per drinking occasion (PDO); 5+ M/4+ W PDO; 8+ M/6+ W PDO; 14+ M/9+ W per week; 3+ PDO; 4+ PDO; 5+ PDO; 6+ PDO; Undefined

Appendix C
Equations Used in Data Collection

Equations for Study Demographics

$$\textbf{\textit{Recruitment Rate}} = \left(\frac{\#\text{ participant at baseline}}{\#\text{ participants screened}}\right) \text{x } 100$$

$$\textbf{\textit{Retention at Follow} - \textit{Up}} = \left(\frac{\#\text{ participants with follow} - \text{up data at last time point}}{\#\text{ participants at baseline}}\right) \text{x } 100$$

Equations Used to Calculate Statistics Required for Meta-Analysis

$$\textbf{\textit{Standard Deviation}} = \left(\text{Standard Error x } \sqrt{\text{sample size}}\right)$$

$$\textbf{\textit{Standard Error of the Mean}} = \frac{\left(\frac{95\%\ CI\ upper\ bound - 95\%\ CI\ lower\ bound}{2}\right)}{\sqrt{\text{sample size}}}$$

$$\textbf{\textit{Standard Deviation}} = Standard\ Error\ of\ the\ Mean\ x\ \sqrt{\text{sample size}}$$

Equations Used to Calculate Pooled Statistics

$$\textbf{\textit{Pooled Mean}} = \frac{[(\text{mean sample 1 x sample size 1}) + (\text{mean sample 2 x sample size 2})]}{(\text{sample size 1} + \text{sample size 2})}$$

$$\textbf{\textit{Pooled Standard Deviation}} = \sqrt{\frac{[(\text{sample size 1} - 1)\text{ x (SD sample } 1^2)] + [(\text{sample size 2} - 1)\text{ x (SD sample } 2^2)]}{(\text{sample size 1} + \text{sample size 2} - 2)}}$$

$$\textbf{\textit{Pooled Sample Size}} = (\text{sample size 1} + \text{sample size 2})$$

Appendix D
Reference List of Included Articles

Agyapong, V. I. O., Ahern, S., McLoughlin, D. M., & Farren, C. K. (2012). Supportive text messaging for depression and comorbid alcohol use disorder: Single-blind randomised trial. *Journal of Affective Disorders*, *141*(2–3), 168-176. https://doi.org/10.1016/j.jad.2012.02.040

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Appendix E
Key Treatment Components

Author	Personalized Feedback	Self-Monitoring	Motivational Interviewing	Goal Setting & Action Planning	Psycho-education	Cognitive Strategies	Behavioral Strategies	Behavioral Modification	Emotional Regulation & Mental Health Support	Peer & Interpersonal Support	Harm Reduction	Relapse Prevention	Operant Conditioning
Agyapong et al., 2012	✓				✓				✓		✓	✓	
Andersson, 2015	✓			✓	✓	✓	✓	✓			✓		
Arnaud et al., 2016	✓		✓	✓	✓	✓	✓	✓			✓	✓	
Augsburger et al., 2022	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Barnett et al., 2007	✓		✓		✓						✓		
Baumgartner et al., 2021	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Becker et al., 2014	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		
Bertholet et al., 2015	✓	✓			✓	✓					✓		
Bewick et al., 2010	✓	✓			✓	✓					✓		
Blankers et al., 2011	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Blow et al., 2017	✓		✓	✓	✓	✓	✓	✓			✓		
Boß et al., 2018	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Bonar et al., 2022a	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bonar et al., 2022b	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Bonar et al., 2023	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Boyle et al., 2022	✓				✓	✓	✓		✓		✓		✓
Braitman et al., 2018	✓			✓	✓	✓	✓	✓			✓		
Brendryen et al., 2014	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓
Buckner et al., 2020	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	
Butler et al., 2009	✓				✓	✓	✓	✓			✓		
Cadigan et al., 2019	✓				✓	✓	✓				✓		✓
Chiauzzi et al., 2005	✓	✓	✓		✓	✓	✓	✓			✓		
Cunningham et al., 2009	✓				✓						✓		
Cunningham, 2012	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	
Cunningham et al., 2021	✓				✓						✓		
Deady et al., 2016		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Delrahim-Howlett et al., 2011	✓				✓						✓		
Donovan et al., 2015	✓			✓	✓	✓	✓	✓	✓		✓		
Doumas et al., 2009	✓				✓						✓		✓
Doumas et al., 2011	✓		✓		✓						✓		✓
Elliot et al., 2014	✓				✓						✓		
Freyer-Adam et al., 2018	✓	✓		✓	✓	✓	✓	✓			✓	✓	
Gajecki et al., 2014	✓	✓		✓	✓		✓	✓			✓		
Gajecki et al., 2017	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓
Geisner et al., 2015	✓				✓	✓	✓	✓	✓		✓		
Gex et al., 2023	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Goodness et al., 2020	✓	✓		✓	✓	✓		✓			✓	✓	
Gryczynski et al., 2021	✓		✓	✓	✓	✓	✓	✓			✓	✓	
Hansen et al., 2012	✓	✓			✓						✓		
Helzer et al., 2008	✓	✓	✓		✓		✓	✓			✓	✓	✓
Hester et al., 2009	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	
Hester et al., 2012 – *Study 1*	✓		✓		✓	✓	✓	✓			✓	✓	
Hester et al., 2012 – *Study 2*	✓		✓		✓	✓	✓	✓			✓	✓	
Ingersoll et al., 2018	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	
Johansson et al., 2021a	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	
Johansson et al., 2021b	✓		✓	✓	✓	✓	✓	✓			✓	✓	
Johnson et al., 2018	✓				✓	✓	✓	✓			✓	✓	

	Personalized Feedback	Self-Monitoring	Motivational Interviewing	Goal Setting & Action Planning	Psycho-education	Cognitive Strategies	Behavioral Strategies	Behavioral Modification	Emotional Regulation & Mental Health Support	Peer & Interpersonal Support	Harm Reduction	Relapse Prevention	Operant Conditioning
Kypri et al., 2009	✓		✓		✓	✓	✓	✓			✓	✓	✓
Kypri et al., 2013	✓				✓	✓	✓	✓			✓	✓	✓
Kypri et al., 2014	✓				✓	✓	✓	✓			✓	✓	✓
LaBrie et al., 2013	✓				✓	✓					✓	✓	✓
Lee et al., 2010	✓		✓		✓	✓	✓	✓			✓	✓	✓
Lee et al., 2021	✓		✓		✓	✓	✓	✓			✓	✓	
Leeman et al., 2016	✓				✓	✓	✓	✓			✓	✓	✓
Lewis et al., 2014	✓				✓	✓					✓	✓	
Liu et al., 2019	✓				✓	✓	✓	✓			✓	✓	
Mason et al., 2014	✓	✓		✓	✓	✓	✓	✓			✓	✓	
Mello et al., 2008	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Muench et al., 2017	✓	✓		✓	✓	✓	✓	✓			✓	✓	✓
Murphy et al., 2010 – *Study 2*	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	
Neighbors et al., 2004	✓				✓	✓					✓		✓
Neighbors et al., 2010	✓				✓	✓					✓		✓
Olthof et al., 2023	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Ondersma et al., 2007	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
Palfai et al., 2014	✓	✓		✓	✓	✓	✓	✓			✓	✓	
Postel et al., 2010	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Riggs et al., 2018	✓	✓		✓	✓	✓	✓	✓			✓	✓	✓
Rooke et al., 2013	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Rose et al., 2017	✓	✓		✓	✓		✓				✓		
Russell et al., 2022	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Satre et al., 2019	✓		✓		✓				✓		✓	✓	
Schaub et al., 2015	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Schaub et al., 2019	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Schluter et al., 2022	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Sinadinovic et al., 2020	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Steers et al., 2016	✓										✓		
Strickland et al., 2019	✓	✓				✓	✓				✓		
Suffoletto et al., 2012	✓	✓		✓	✓		✓	✓			✓	✓	✓
Suffoletto et al., 2015	✓	✓		✓	✓		✓	✓			✓	✓	✓
Sundström et al., 2020	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	
Teeters et al., 2018	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓
Tello et al., 2018						✓	✓	✓			✓		
Tensil et al., 2013	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	
Tossmann et al., 2011	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	
Van Dessel et al., 2023 – *Study 1*				✓		✓	✓	✓			✓		✓
Van Dessel et al., 2023 – *Study 2*				✓		✓	✓	✓			✓		✓
Voogt et al., 2013a	✓	✓	✓	✓	✓	✓	✓				✓		
Voogt et al., 2013b	✓	✓	✓	✓	✓	✓	✓				✓		
Voogt et al., 2014	✓	✓	✓	✓	✓	✓	✓				✓	✓	
Wagener et al., 2012	✓	✓	✓	✓	✓	✓	✓				✓		
Wallace et al., 2011	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Walton et al., 2013	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓
Wirtz et al., 2022		✓		✓	✓	✓	✓	✓	✓		✓		
Witkiewitz et al., 2014	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓
Young et al., 2019	✓			✓	✓	✓	✓		✓		✓		✓

Appendix F
Funnel Plots for Trim-and-Fill Procedure

Figure F1. Funnel plot of standard error by Hedges g to assess publication bias on alcohol use outcomes at post-treatment

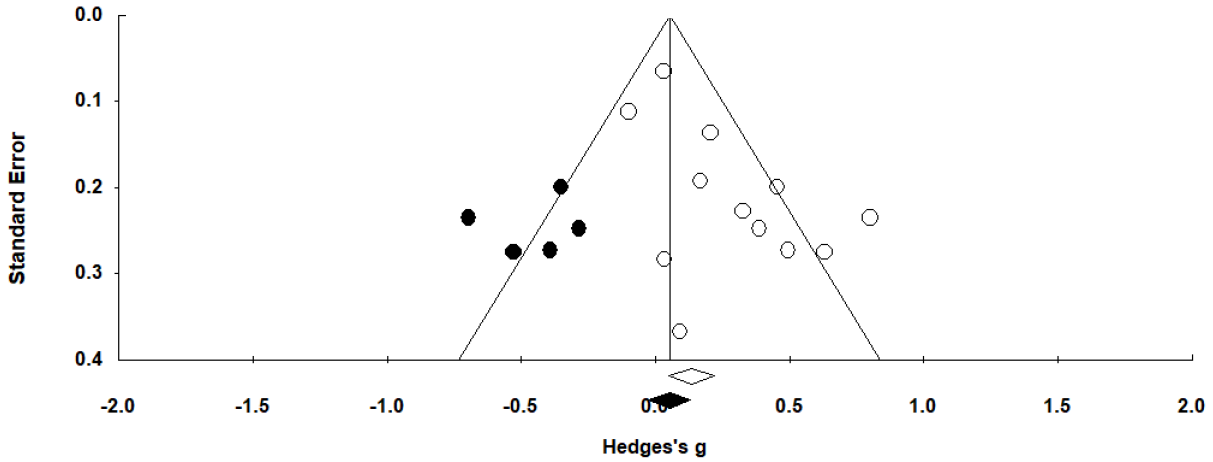


Figure F2. Funnel plot of standard error by Hedges g to assess publication bias on alcohol use outcomes at follow-up

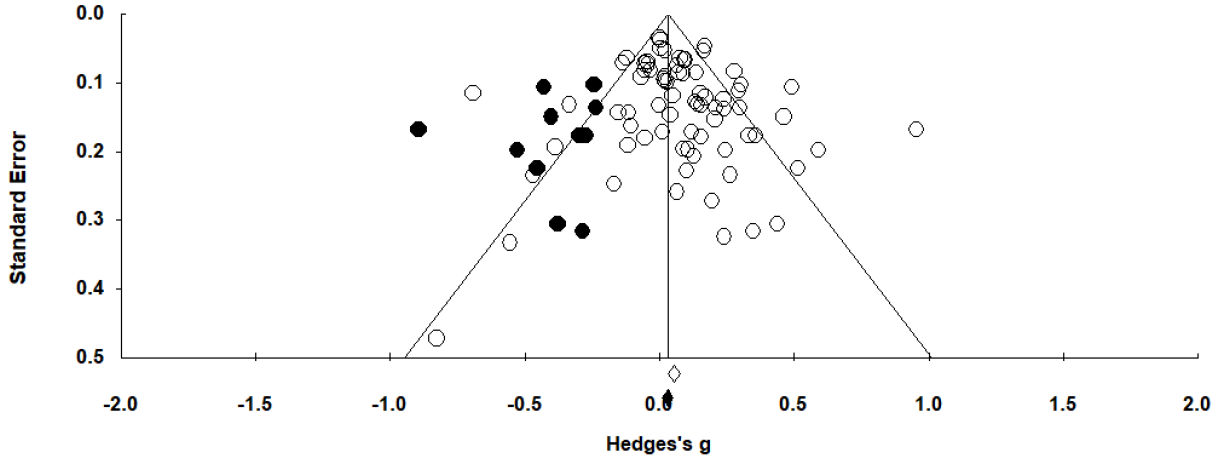
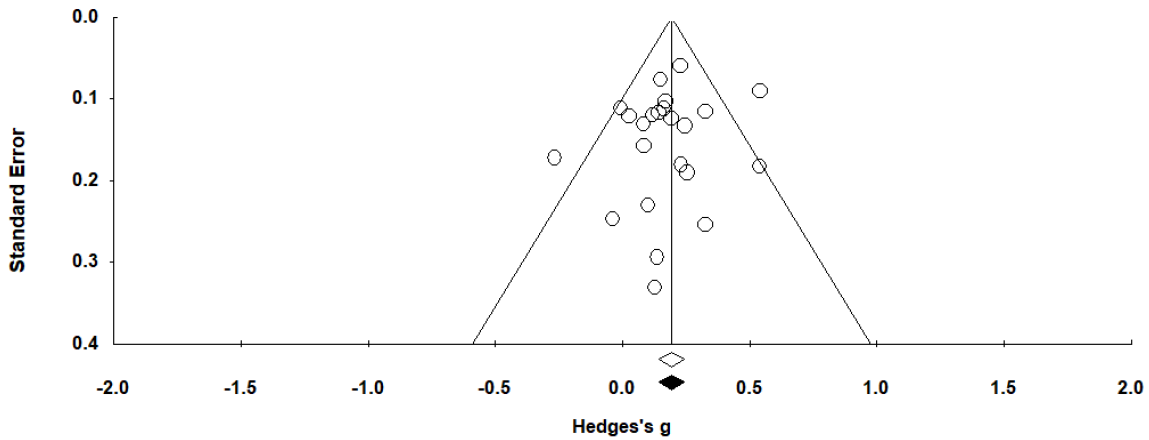


Figure F3. Funnel plot of standard error by Hedges g to assess publication bias on cannabis use outcomes at follow-up



Appendix G

Post-Treatment Alcohol Use Outcomes - Moderation Analyses

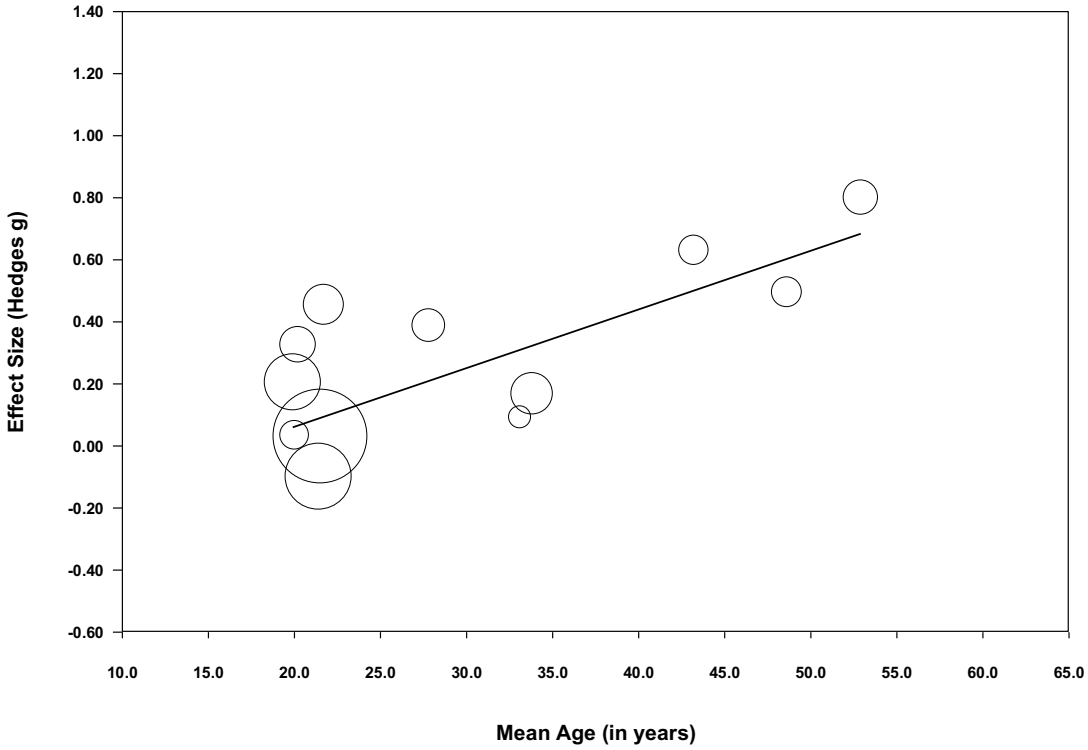


Figure G1. Scatterplot of the post-treatment regression of alcohol use outcome effect sizes (hedges *g*) on mean age (in years)

Table G1. Post-treatment alcohol use outcomes moderated by college/university sample (i.e., 0 = no, 1 = yes)

Group by College/University Sample	Study	Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
0.00	Agyapong et al., 2012	0.496	-0.039	1.030	1.819	0.069
0.00	Deady et al., 2016	0.455	0.064	0.846	2.282	0.022
0.00	Ingersoll et al., 2018	0.388	-0.097	0.874	1.567	0.117
0.00	Muench et al., 2017	0.631	0.091	1.170	2.292	0.022
0.00	Schaub et al., 2019	0.092	-0.627	0.812	0.252	0.801
0.00	Sundstrom et al., 2020	0.801	0.340	1.261	3.407	0.001
0.00	Wirtz et al., 2022	0.168	-0.209	0.545	0.875	0.382
0.00	Pooled	0.436	0.255	0.616	4.725	0.000
1.00	Bewick et al., 2010	0.031	-0.097	0.159	0.470	0.638
1.00	Butler et al., 2009	0.327	-0.118	0.772	1.439	0.150
1.00	Chiauzzi et al., 2005	0.205	-0.062	0.472	1.505	0.132
1.00	Donovan et al., 2015	-0.099	-0.318	0.120	-0.884	0.377
1.00	Gex et al., 2023	0.034	-0.521	0.590	0.122	0.903
1.00	Pooled	0.046	-0.062	0.153	0.837	0.403
Overall	Pooled	0.148	0.055	0.240	3.133	0.002

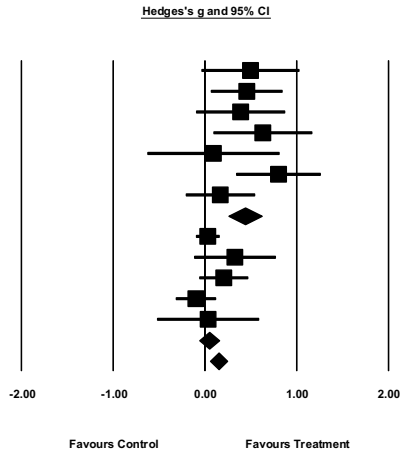


Table F2. Post-treatment alcohol use outcomes moderated by an at-risk substance use inclusion requirement (i.e., 0 = no, 1 = yes)

Group by Substance Use Measure Completed	Study	Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
0.00	Bewick et al., 2010	0.031	-0.097	0.159	0.470	0.638
0.00	Butler et al., 2009	0.327	-0.118	0.772	1.439	0.150
0.00	Chiauzzi et al., 2005	0.205	-0.062	0.472	1.505	0.132
0.00	Donovan et al., 2015	-0.099	-0.318	0.120	-0.884	0.377
0.00	Gex et al., 2023	0.034	-0.521	0.590	0.122	0.903
0.00	Ingersoll et al., 2018	0.388	-0.097	0.874	1.567	0.117
0.00	Muench et al., 2017	0.631	0.091	1.170	2.292	0.022
0.00	Schaub et al., 2019	0.092	-0.627	0.812	0.252	0.801
0.00	Wirtz et al., 2022	0.168	-0.209	0.545	0.875	0.382
0.00	Pooled	0.110	-0.009	0.228	1.808	0.071
1.00	Agyapong et al., 2012	0.496	-0.039	1.030	1.819	0.069
1.00	Deady et al., 2016	0.455	0.064	0.846	2.282	0.022
1.00	Sundstrom et al., 2020	0.801	0.340	1.261	3.407	0.001
1.00	Pooled	0.577	0.300	0.853	4.088	0.000
Overall	Pooled	0.182	0.073	0.292	3.275	0.001

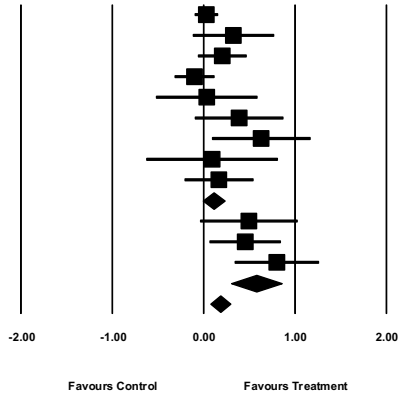
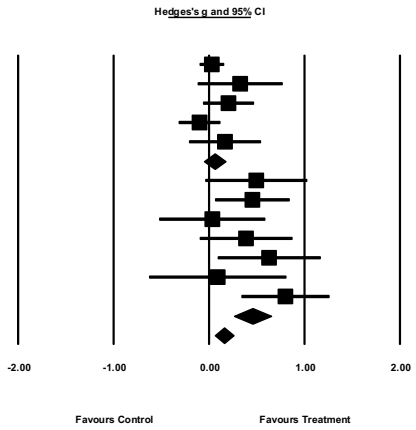


Table F3. Alcohol use at post-treatment moderated by relapse prevention component (0 = no, 1 = yes)

Group by Relapse Prevention	Study	Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
0.00	Bewick et al., 2010	0.031	-0.097	0.159	0.470	0.638
0.00	Butler et al., 2009	0.327	-0.118	0.772	1.439	0.150
0.00	Chiauzzi et al., 2005	0.205	-0.062	0.472	1.505	0.132
0.00	Donovan et al., 2015	-0.099	-0.318	0.120	-0.884	0.377
0.00	Wirtz et al., 2022	0.168	-0.209	0.545	0.875	0.382
0.00	Pooled	0.059	-0.053	0.171	1.029	0.303
1.00	Agyapong et al., 2012	0.496	-0.039	1.030	1.819	0.069
1.00	Deady et al., 2016	0.455	0.064	0.846	2.282	0.022
1.00	Gex et al., 2023	0.034	-0.521	0.590	0.122	0.903
1.00	Ingersoll et al., 2018	0.388	-0.097	0.874	1.567	0.117
1.00	Muench et al., 2017	0.631	0.091	1.170	2.292	0.022
1.00	Schaub et al., 2019	0.092	-0.627	0.812	0.252	0.801
1.00	Sundstrom et al., 2020	0.801	0.340	1.261	3.407	0.001
1.00	Pooled	0.455	0.261	0.649	4.593	0.000
Overall	Pooled	0.158	0.061	0.255	3.185	0.001



Appendix H

Follow-Up Alcohol Use Outcomes - Moderation Analyses

Table H1. Alcohol use at follow-up moderated by intention-to-treat analysis (i.e., 0 = no, 1 = yes)

Group by ITT Analysis	Study Name	Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
0.00	Murphy et al., 2010	0.591	0.202	0.979	2.981	0.003
0.00	Schaub et al., 2019	0.439	-0.161	1.039	1.434	0.152
0.00	Pooled	0.539	0.151	0.927	2.720	0.007
1.00	Andersson, 2015	0.077	-0.047	0.201	1.212	0.225
1.00	Arnaud et al., 2016	0.021	-0.081	0.124	0.409	0.682
1.00	Augsburger et al., 2022	0.278	0.116	0.440	3.363	0.001
1.00	Bertholet et al., 2015	-0.044	-0.188	0.101	-0.592	0.554
1.00	Blankers et al., 2011	0.462	0.170	0.754	3.101	0.002
1.00	Boß et al., 2018	0.304	0.103	0.505	2.968	0.003
1.00	Bonar et al., 2022a	-0.045	-0.180	0.090	-0.659	0.510
1.00	Brendryen et al., 2014	0.133	-0.117	0.384	1.044	0.297
1.00	Chiauzzi et al., 2005	0.209	-0.058	0.476	1.533	0.125
1.00	Cunningham et al., 2009	0.041	-0.246	0.328	0.280	0.780
1.00	Cunningham et al., 2012	0.207	-0.093	0.507	1.352	0.176
1.00	Deady et al., 2016	0.106	-0.280	0.493	0.539	0.590
1.00	Donovan et al., 2015	-0.691	-0.917	-0.466	-6.011	0.000
1.00	Gajecki et al., 2014	-0.122	-0.247	0.003	-1.914	0.056
1.00	Geisner et al., 2015	0.240	-0.030	0.511	1.739	0.082
1.00	Gryczynski et al., 2021	0.171	-0.067	0.409	1.407	0.159
1.00	Hansen et al., 2012	-0.139	-0.278	0.001	-1.948	0.051
1.00	Hester et al., 2009	-0.471	-0.931	-0.010	-2.003	0.045
1.00	Ingersoll et al., 2018	-0.169	-0.654	0.316	-0.683	0.495
1.00	Johansson et al., 2021a	0.138	-0.028	0.304	1.627	0.104
1.00	Johansson et al., 2021b	-0.153	-0.433	0.127	-1.071	0.284
1.00	Johnson et al., 2018	-0.056	-0.197	0.084	-0.783	0.434
1.00	Kypri et al., 2009	0.169	0.079	0.259	3.672	0.000
1.00	Kypri et al., 2013	0.165	0.061	0.269	3.096	0.002
1.00	Kypri et al., 2014	0.004	-0.070	0.077	0.098	0.922
1.00	Lee et al., 2021	0.155	-0.196	0.505	0.864	0.387
1.00	Leeman et al., 2016	0.087	-0.299	0.472	0.442	0.659
1.00	Lewis et al., 2014	0.293	0.074	0.512	2.617	0.009
1.00	Mello et al., 2008	0.087	-0.081	0.255	1.014	0.311
1.00	Postel et al., 2010	0.956	0.626	1.285	5.679	0.000
1.00	Rose et al., 2017	0.004	-0.094	0.102	0.079	0.937
1.00	Schaub et al., 2015	0.238	-0.005	0.481	1.916	0.055
1.00	Sinadinovic et al., 2020	0.152	-0.073	0.377	1.326	0.185
1.00	Suffoletto et al., 2015	0.016	-0.170	0.201	0.167	0.867
1.00	Teeters et al., 2018	0.102	-0.343	0.548	0.449	0.653
1.00	Tensil et al., 2013	-0.033	-0.194	0.127	-0.406	0.685
1.00	Van Dessel et al., 2023 - Study 1	-0.115	-0.396	0.167	-0.799	0.424
1.00	Van Dessel et al., 2023 - Study 2	0.050	-0.183	0.282	0.417	0.677
1.00	Voogt et al., 2013a	0.097	-0.034	0.227	1.455	0.146
1.00	Voogt et al., 2013b	-0.058	-0.217	0.101	-0.712	0.477
1.00	Voogt et al., 2014	0.091	-0.039	0.221	1.368	0.171
1.00	Wirtz et al., 2022	-0.387	-0.766	-0.007	-1.997	0.046
1.00	Witkiewitz et al., 2014	0.261	-0.197	0.720	1.117	0.264
1.00	Pooled	0.063	0.009	0.117	2.281	0.023
Overall	Pooled	0.072	0.019	0.126	2.636	0.008

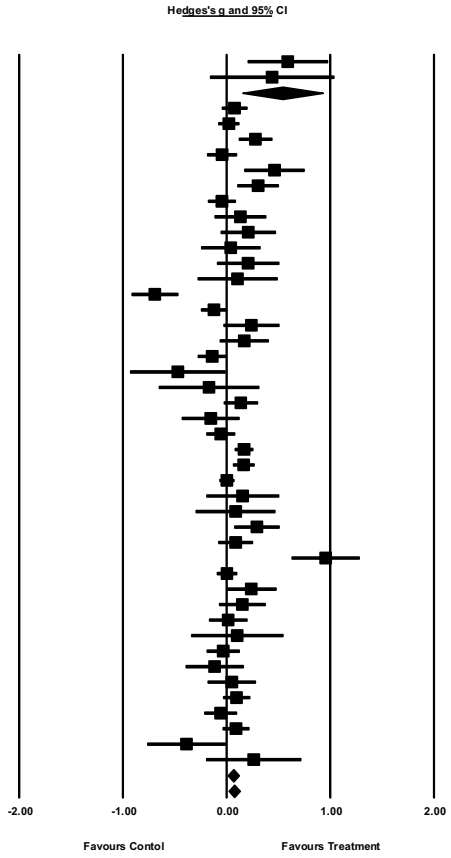
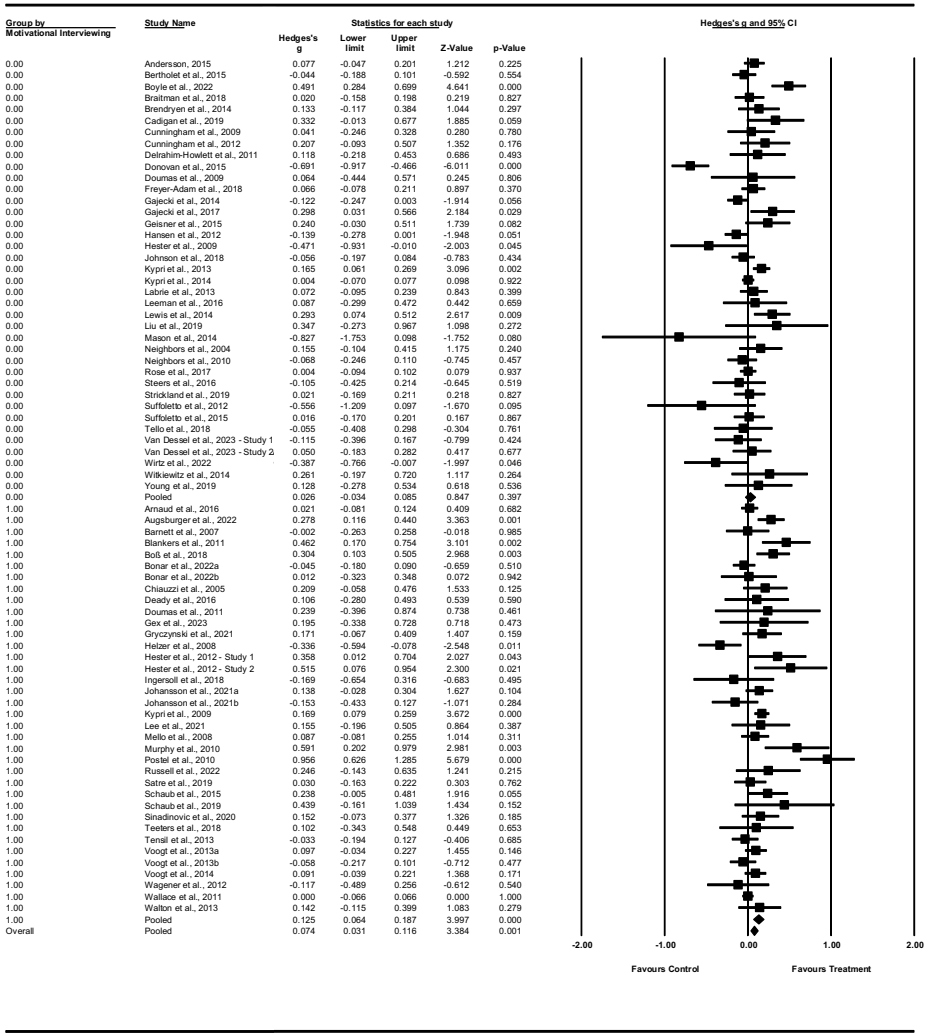
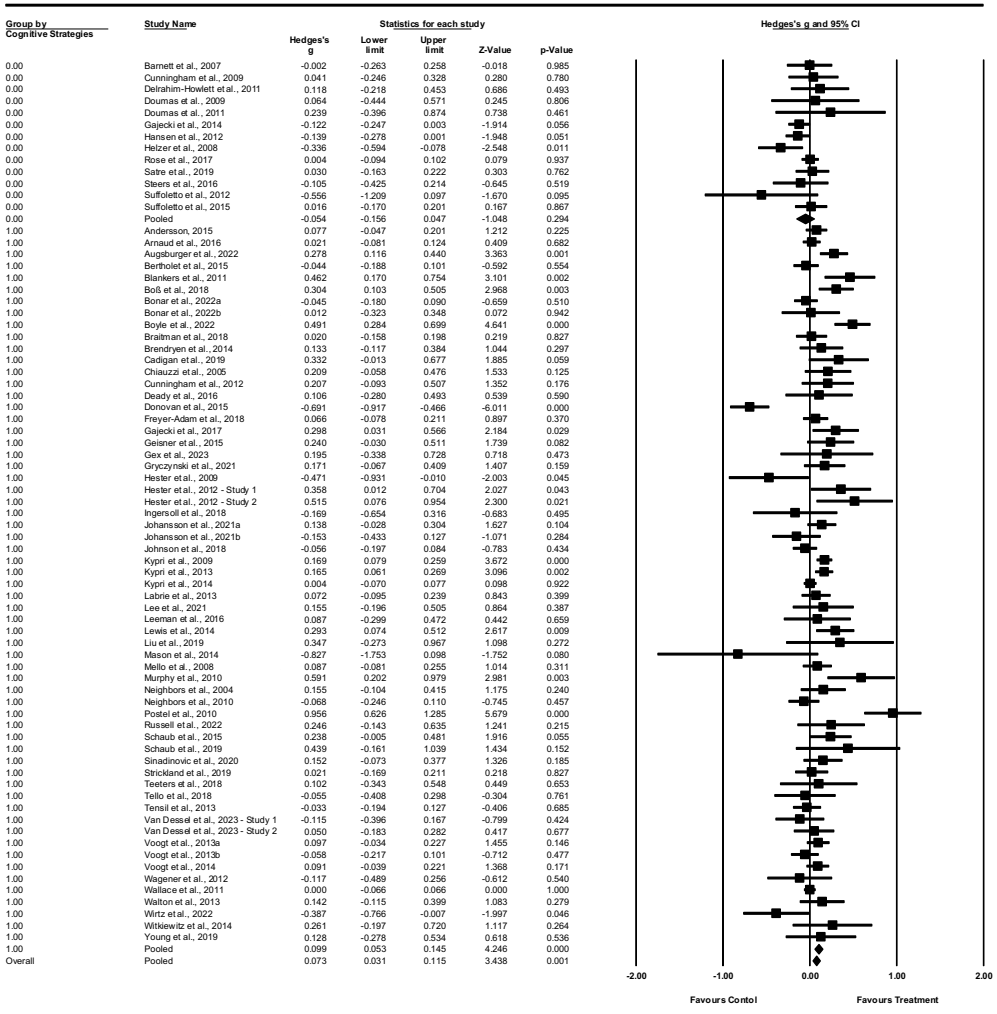


Figure H2. Alcohol use at follow-up grouped by motivational interviewing (i.e., 0 = no, 1 = yes)



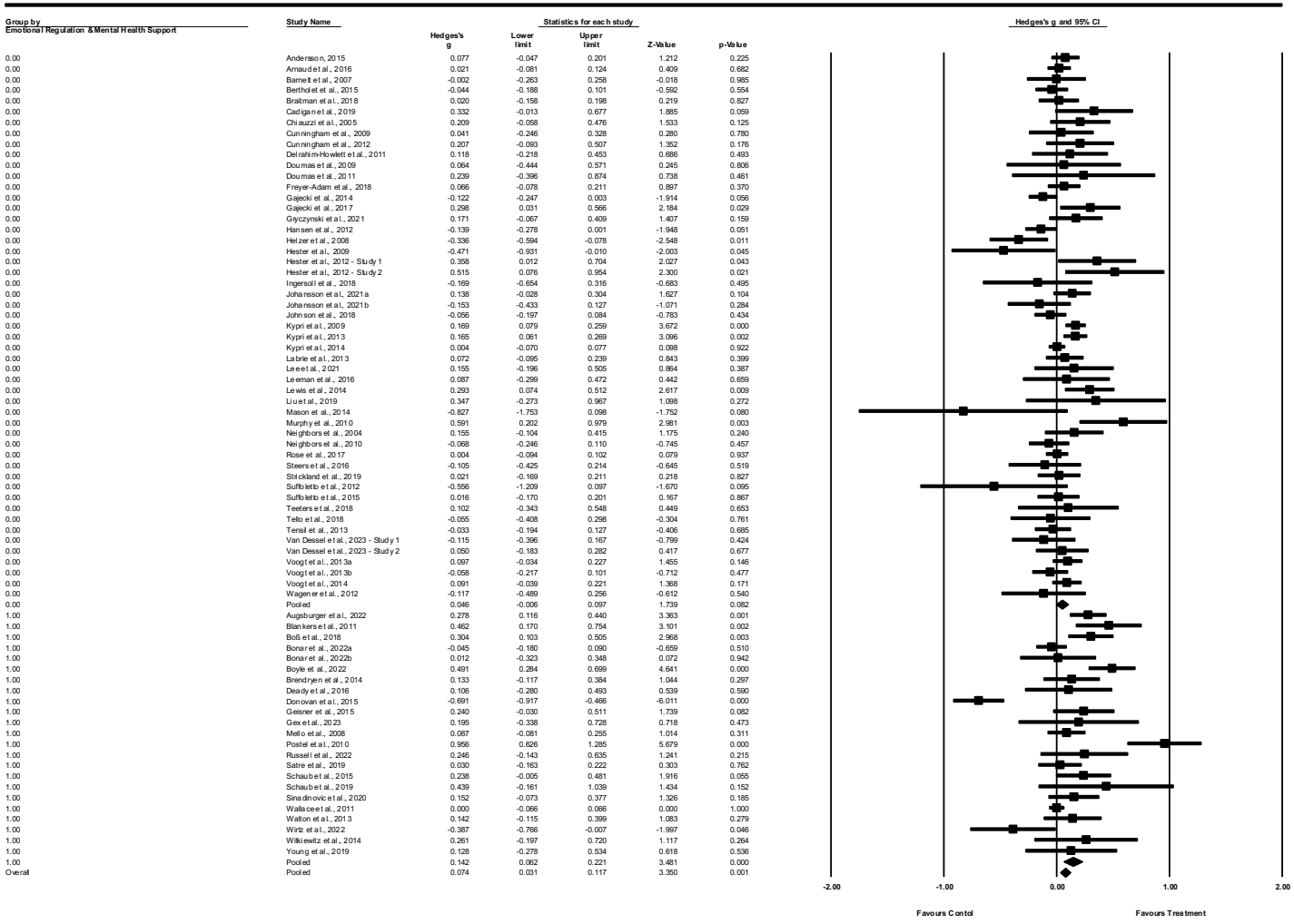
Group by Motivational Interviewing	Study Name	Statistics for each study				
		Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
0.00	Andersson, 2015	0.077	-0.047	0.201	1.212	0.225
0.00	Bertholet et al., 2015	-0.044	-0.188	0.101	-0.592	0.554
0.00	Boyle et al., 2022	0.491	0.284	0.699	4.641	0.000
0.00	Braitman et al., 2018	0.020	-0.158	0.198	0.219	0.827
0.00	Brendryen et al., 2014	0.133	-0.117	0.384	1.044	0.297
0.00	Cadigan et al., 2019	0.332	-0.013	0.677	1.885	0.059
0.00	Cunningham et al., 2009	0.041	-0.246	0.328	0.280	0.780
0.00	Cunningham et al., 2012	0.207	-0.093	0.507	1.352	0.176
0.00	Delrahim-Howlett et al., 2011	0.118	-0.218	0.453	0.686	0.493
0.00	Donovan et al., 2015	-0.691	-0.917	-0.466	-6.011	0.000
0.00	Doumas et al., 2009	0.064	-0.444	0.571	0.245	0.806
0.00	Freyer-Adam et al., 2018	0.066	-0.078	0.211	0.897	0.370
0.00	Gajecki et al., 2014	-0.122	-0.247	0.003	-1.914	0.056
0.00	Gajecki et al., 2017	0.298	0.031	0.566	2.184	0.029
0.00	Geisner et al., 2015	0.240	-0.030	0.511	1.739	0.082
0.00	Hansen et al., 2012	-0.139	-0.278	0.001	-1.948	0.051
0.00	Hester et al., 2009	-0.471	-0.931	-0.010	-2.003	0.045
0.00	Johnson et al., 2018	-0.056	-0.197	0.084	-0.783	0.434
0.00	Kypri et al., 2013	0.165	0.061	0.269	3.096	0.002
0.00	Kypri et al., 2014	0.004	-0.070	0.077	0.098	0.922
0.00	Labrie et al., 2013	0.072	-0.095	0.239	0.843	0.399
0.00	Leeman et al., 2016	0.087	-0.299	0.472	0.442	0.659
0.00	Lewis et al., 2014	0.293	0.074	0.512	2.617	0.009
0.00	Liu et al., 2019	0.347	-0.273	0.967	1.098	0.272
0.00	Mason et al., 2014	-0.827	-1.753	0.098	-1.752	0.080
0.00	Neighbors et al., 2004	0.155	-0.104	0.415	1.175	0.240
0.00	Neighbors et al., 2010	-0.068	-0.246	0.110	-0.745	0.457
0.00	Rose et al., 2017	0.004	-0.094	0.102	0.079	0.937
0.00	Steers et al., 2016	-0.105	-0.425	0.214	-0.645	0.519
0.00	Strickland et al., 2019	0.021	-0.169	0.211	0.218	0.827
0.00	Suffoletto et al., 2012	-0.556	-1.209	0.097	-1.670	0.095
0.00	Suffoletto et al., 2015	0.016	-0.170	0.201	0.167	0.867
0.00	Tello et al., 2018	-0.055	-0.408	0.298	-0.304	0.761
0.00	Van Dessel et al., 2023 - Study 1	-0.115	-0.396	0.167	-0.799	0.424
0.00	Van Dessel et al., 2023 - Study 2	0.050	-0.183	0.282	0.417	0.677
0.00	Wirtz et al., 2022	-0.387	-0.766	-0.007	-1.997	0.046
0.00	Witkiewitz et al., 2014	0.261	-0.197	0.720	1.117	0.264
0.00	Young et al., 2019	0.128	-0.278	0.534	0.618	0.536
0.00	Pooled	0.026	-0.034	0.085	0.847	0.397
1.00	Arnaud et al., 2016	0.021	-0.081	0.124	0.409	0.682
1.00	Augsburger et al., 2022	0.278	0.116	0.440	3.363	0.001
1.00	Barnett et al., 2007	-0.002	-0.263	0.258	-0.018	0.985
1.00	Blankers et al., 2011	0.462	0.170	0.754	3.101	0.002
1.00	Boß et al., 2018	0.304	0.103	0.505	2.968	0.003
1.00	Bonar et al., 2022a	-0.045	-0.180	0.090	-0.659	0.510
1.00	Bonar et al., 2022b	0.012	-0.323	0.348	0.072	0.942
1.00	Chiauzzi et al., 2005	0.209	-0.058	0.476	1.533	0.125
1.00	Deady et al., 2016	0.106	-0.280	0.493	0.539	0.590
1.00	Doumas et al., 2011	0.239	-0.396	0.874	0.738	0.461
1.00	Gex et al., 2023	0.195	-0.338	0.728	0.718	0.473
1.00	Gryczynski et al., 2021	0.171	-0.067	0.409	1.407	0.159
1.00	Helzer et al., 2008	-0.336	-0.594	-0.078	-2.548	0.011
1.00	Hester et al., 2012 - Study 1	0.358	0.012	0.704	2.027	0.043
1.00	Hester et al., 2012 - Study 2	0.515	0.076	0.954	2.300	0.021
1.00	Ingersoll et al., 2018	-0.169	-0.654	0.316	-0.683	0.495
1.00	Johansson et al., 2021a	0.138	-0.028	0.304	1.627	0.104
1.00	Johansson et al., 2021b	-0.153	-0.433	0.127	-1.071	0.284
1.00	Kypri et al., 2009	0.169	0.079	0.259	3.672	0.000
1.00	Lee et al., 2021	0.155	-0.196	0.505	0.864	0.387
1.00	Mello et al., 2008	0.087	-0.081	0.255	1.014	0.311
1.00	Murphy et al., 2010	0.591	0.202	0.979	2.981	0.003
1.00	Postel et al., 2010	0.956	0.626	1.285	5.679	0.000
1.00	Russell et al., 2022	0.246	-0.143	0.635	1.241	0.215
1.00	Satre et al., 2019	0.030	-0.163	0.222	0.303	0.762
1.00	Schaub et al., 2015	0.238	-0.005	0.481	1.916	0.055
1.00	Schaub et al., 2019	0.439	-0.161	1.039	1.434	0.152
1.00	Sinadinovic et al., 2020	0.152	-0.073	0.377	1.326	0.185
1.00	Teeters et al., 2018	0.102	-0.343	0.548	0.449	0.653
1.00	Tensil et al., 2013	-0.033	-0.194	0.127	-0.406	0.685
1.00	Voogt et al., 2013a	0.097	-0.034	0.227	1.455	0.146
1.00	Voogt et al., 2013b	-0.058	-0.217	0.101	-0.712	0.477
1.00	Voogt et al., 2014	0.091	-0.039	0.221	1.368	0.171
1.00	Wagener et al., 2012	-0.117	-0.489	0.256	-0.612	0.540
1.00	Wallace et al., 2011	0.000	-0.066	0.066	0.000	1.000
1.00	Walton et al., 2013	0.142	-0.115	0.399	1.083	0.279
1.00	Pooled	0.125	0.064	0.187	3.997	0.000
Overall	Pooled	0.074	0.031	0.116	3.384	0.001

Table H3. Alcohol use at follow-up moderated by cognitive strategies (i.e., 0 = no, 1 = yes)



Group by Cognitive Strategies	Study Name	Statistics for each study				
		Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
0.00	Barnett et al., 2007	-0.002	-0.263	0.258	-0.018	0.985
0.00	Cunningham et al., 2009	0.041	-0.246	0.328	0.280	0.780
0.00	Delrahim-Howlett et al., 2011	0.118	-0.218	0.453	0.686	0.493
0.00	Doumas et al., 2009	0.064	-0.444	0.571	0.245	0.806
0.00	Doumas et al., 2011	0.239	-0.396	0.874	0.738	0.461
0.00	Gajecki et al., 2014	-0.122	-0.247	0.003	-1.914	0.056
0.00	Hansen et al., 2012	-0.139	-0.278	0.001	-1.948	0.051
0.00	Helzer et al., 2008	-0.336	-0.594	-0.078	-2.548	0.011
0.00	Rose et al., 2017	0.004	-0.094	0.102	0.079	0.937
0.00	Satre et al., 2019	0.030	-0.163	0.222	0.303	0.762
0.00	Steers et al., 2016	-0.105	-0.425	0.214	-0.645	0.519
0.00	Suffoletto et al., 2012	-0.556	-1.209	0.097	-1.670	0.095
0.00	Suffoletto et al., 2015	0.016	-0.170	0.201	0.167	0.867
0.00	Pooled	-0.054	-0.156	0.047	-1.048	0.294
1.00	Andersson, 2015	0.077	-0.047	0.201	1.212	0.225
1.00	Arnaud et al., 2016	0.021	-0.081	0.124	0.409	0.682
1.00	Augsburger et al., 2022	0.278	0.116	0.440	3.363	0.001
1.00	Bertholet et al., 2015	-0.044	-0.188	0.101	-0.592	0.554
1.00	Blankers et al., 2011	0.462	0.170	0.754	3.101	0.002
1.00	Boß et al., 2018	0.304	0.103	0.505	2.968	0.003
1.00	Bonar et al., 2022a	-0.045	-0.180	0.090	-0.659	0.510
1.00	Bonar et al., 2022b	0.012	-0.323	0.348	0.072	0.942
1.00	Boyle et al., 2022	0.491	0.284	0.699	4.641	0.000
1.00	Braitman et al., 2018	0.020	-0.158	0.198	0.219	0.827
1.00	Brendryen et al., 2014	0.133	-0.117	0.384	1.044	0.297
1.00	Cadigan et al., 2019	0.332	-0.013	0.677	1.885	0.059
1.00	Chiauzzi et al., 2005	0.209	-0.058	0.476	1.533	0.125
1.00	Cunningham et al., 2012	0.207	-0.093	0.507	1.352	0.176
1.00	Deady et al., 2016	0.106	-0.280	0.493	0.539	0.590
1.00	Donovan et al., 2015	-0.691	-0.917	-0.466	-6.011	0.000
1.00	Freyer-Adam et al., 2018	0.066	-0.078	0.211	0.897	0.370
1.00	Gajecki et al., 2017	0.298	0.031	0.566	2.184	0.029
1.00	Geisner et al., 2015	0.240	-0.030	0.511	1.739	0.082
1.00	Gex et al., 2023	0.195	-0.338	0.728	0.718	0.473
1.00	Gryczynski et al., 2021	0.171	-0.067	0.409	1.407	0.159
1.00	Hester et al., 2009	-0.471	-0.931	-0.010	-2.003	0.045
1.00	Hester et al., 2012 - Study 1	0.358	0.012	0.704	2.027	0.043
1.00	Hester et al., 2012 - Study 2	0.515	0.076	0.954	2.300	0.021
1.00	Ingersoll et al., 2018	-0.169	-0.654	0.316	-0.683	0.495
1.00	Johansson et al., 2021a	0.138	-0.028	0.304	1.627	0.104
1.00	Johansson et al., 2021b	-0.153	-0.433	0.127	-1.071	0.284
1.00	Johnson et al., 2018	-0.056	-0.197	0.084	-0.783	0.434
1.00	Kypri et al., 2009	0.169	0.079	0.259	3.672	0.000
1.00	Kypri et al., 2013	0.165	0.061	0.269	3.096	0.002
1.00	Kypri et al., 2014	0.004	-0.070	0.077	0.098	0.922
1.00	Labrie et al., 2013	0.072	-0.095	0.239	0.843	0.399
1.00	Lee et al., 2021	0.155	-0.196	0.505	0.864	0.387
1.00	Leeman et al., 2016	0.087	-0.299	0.472	0.442	0.659
1.00	Lewis et al., 2014	0.293	0.074	0.512	2.617	0.009
1.00	Liu et al., 2019	0.347	-0.273	0.967	1.098	0.272
1.00	Mason et al., 2014	-0.827	-1.753	0.098	-1.752	0.080
1.00	Mello et al., 2008	0.087	-0.081	0.255	1.014	0.311
1.00	Murphy et al., 2010	0.591	0.202	0.979	2.981	0.003
1.00	Neighbors et al., 2004	0.155	-0.104	0.415	1.175	0.240
1.00	Neighbors et al., 2010	-0.068	-0.246	0.110	-0.745	0.457
1.00	Postel et al., 2010	0.956	0.626	1.285	5.679	0.000
1.00	Russell et al., 2022	0.246	-0.143	0.635	1.241	0.215
1.00	Schaub et al., 2015	0.238	-0.005	0.481	1.916	0.055
1.00	Schaub et al., 2019	0.439	-0.161	1.039	1.434	0.152
1.00	Sinadinovic et al., 2020	0.152	-0.073	0.377	1.326	0.185
1.00	Strickland et al., 2019	0.021	-0.169	0.211	0.218	0.827
1.00	Teeters et al., 2018	0.102	-0.343	0.548	0.449	0.653
1.00	Tello et al., 2018	-0.055	-0.408	0.298	-0.304	0.761
1.00	Tensil et al., 2013	-0.033	-0.194	0.127	-0.406	0.685
1.00	Van Dessel et al., 2023 - Study 1	-0.115	-0.396	0.167	-0.799	0.424
1.00	Van Dessel et al., 2023 - Study 2	0.050	-0.183	0.282	0.417	0.677
1.00	Voogt et al., 2013a	0.097	-0.034	0.227	1.455	0.146
1.00	Voogt et al., 2013b	-0.058	-0.217	0.101	-0.712	0.477
1.00	Voogt et al., 2014	0.091	-0.039	0.221	1.368	0.171
1.00	Wagener et al., 2012	-0.117	-0.489	0.256	-0.612	0.540
1.00	Wallace et al., 2011	0.000	-0.066	0.066	0.000	1.000
1.00	Walton et al., 2013	0.142	-0.115	0.399	1.083	0.279
1.00	Wirtz et al., 2022	-0.387	-0.766	-0.007	-1.997	0.046
1.00	Witkiewitz et al., 2014	0.261	-0.197	0.720	1.117	0.264
1.00	Young et al., 2019	0.128	-0.278	0.534	0.618	0.536
1.00	Pooled	0.099	0.053	0.145	4.246	0.000
Overall	Pooled	0.073	0.031	0.115	3.438	0.001

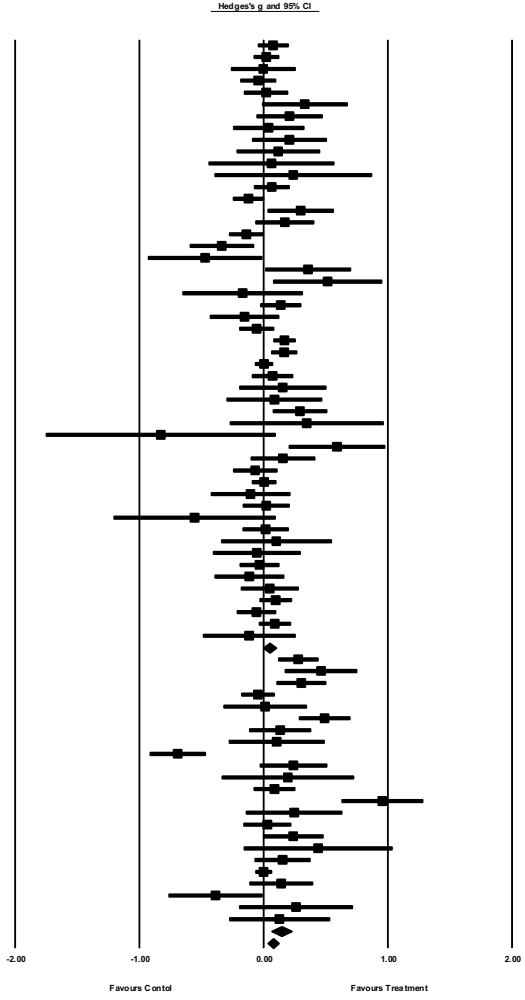
Table H4. Alcohol use at follow-up moderated by emotional regulation and mental health support (i.e., 0 = no, 1 = yes)



Group by Emotional Regulation &Mental Health Support	Study Name	Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
0.00	Andersson, 2015	0.077	-0.047	0.201	1.212	0.225
0.00	Arnaud et al., 2016	0.021	-0.081	0.124	0.409	0.682
0.00	Barnett et al., 2007	-0.002	-0.263	0.258	-0.018	0.985
0.00	Bertholet et al., 2015	-0.044	-0.188	0.101	-0.592	0.554
0.00	Brailman et al., 2018	0.020	-0.158	0.198	0.219	0.827
0.00	Cadigan et al., 2019	0.332	-0.013	0.677	1.885	0.059
0.00	Chiauzzi et al., 2005	0.209	-0.058	0.476	1.533	0.125
0.00	Cunningham et al., 2009	0.041	-0.246	0.328	0.280	0.780
0.00	Cunningham et al., 2012	0.207	-0.093	0.507	1.352	0.176
0.00	Delrahim-Howlett et al., 2011	0.118	-0.218	0.453	0.686	0.493
0.00	Doumas et al., 2009	0.064	-0.444	0.571	0.245	0.806
0.00	Doumas et al., 2011	0.239	-0.396	0.874	0.738	0.461
0.00	Freyer-Adam et al., 2018	0.066	-0.078	0.211	0.897	0.370
0.00	Gajecki et al., 2014	-0.122	-0.247	0.003	-1.914	0.056
0.00	Gajecki et al., 2017	0.298	0.031	0.566	2.184	0.029
0.00	Gryczynski et al., 2021	0.171	-0.067	0.409	1.407	0.159
0.00	Hansen et al., 2012	-0.139	-0.278	0.001	-1.948	0.051
0.00	Helzer et al., 2008	-0.336	-0.594	-0.078	-2.548	0.011
0.00	Hester et al., 2009	-0.471	-0.931	-0.010	-2.003	0.045
0.00	Hester et al., 2012 - Study 1	0.358	0.012	0.704	2.027	0.043
0.00	Hester et al., 2012 - Study 2	0.515	0.076	0.954	2.300	0.021
0.00	Ingersoll et al., 2018	-0.169	-0.654	0.316	-0.683	0.495
0.00	Johansson et al., 2021a	0.138	-0.028	0.304	1.627	0.104
0.00	Johansson et al., 2021b	-0.153	-0.433	0.127	-1.071	0.284
0.00	Johnson et al., 2018	-0.056	-0.197	0.084	-0.783	0.434
0.00	Kypri et al., 2009	0.169	0.079	0.259	3.672	0.000
0.00	Kypri et al., 2013	0.165	0.061	0.269	3.096	0.002
0.00	Kypri et al., 2014	0.004	-0.070	0.077	0.098	0.922
0.00	Labrie et al., 2013	0.072	-0.095	0.239	0.843	0.399
0.00	Lee et al., 2021	0.155	-0.196	0.505	0.864	0.387
0.00	Leeman et al., 2016	0.087	-0.299	0.472	0.442	0.659
0.00	Lewis et al., 2014	0.293	0.074	0.512	2.617	0.009
0.00	Liu et al., 2019	0.347	-0.273	0.967	1.098	0.272
0.00	Mason et al., 2014	-0.827	-1.753	0.098	-1.752	0.080
0.00	Murphy et al., 2010	0.591	0.202	0.979	2.981	0.003
0.00	Neighbors et al., 2004	0.155	-0.104	0.415	1.175	0.240
0.00	Neighbors et al., 2010	-0.068	-0.246	0.110	-0.745	0.457
0.00	Rose et al., 2017	0.004	-0.094	0.102	0.079	0.937
0.00	Steers et al., 2016	-0.105	-0.425	0.214	-0.645	0.519
0.00	Strickland et al., 2019	0.021	-0.169	0.211	0.218	0.827
0.00	Suffoletto et al., 2012	-0.556	-1.209	0.097	-1.670	0.095
0.00	Suffoletto et al., 2015	0.016	-0.170	0.201	0.167	0.867
0.00	Teeters et al., 2018	0.102	-0.343	0.548	0.449	0.653
0.00	Tello et al., 2018	-0.055	-0.408	0.298	-0.304	0.761
0.00	Tensil et al., 2013	-0.033	-0.194	0.127	-0.406	0.685
0.00	Van Dessel et al., 2023 - Study 1	-0.115	-0.396	0.167	-0.799	0.424
0.00	Van Dessel et al., 2023 - Study 2	0.050	-0.183	0.282	0.417	0.677
0.00	Voogt et al., 2013a	0.097	-0.034	0.227	1.455	0.146
0.00	Voogt et al., 2013b	-0.058	-0.217	0.101	-0.712	0.477
0.00	Voogt et al., 2014	0.091	-0.039	0.221	1.368	0.171
0.00	Wagener et al., 2012	-0.117	-0.489	0.256	-0.612	0.540
0.00	Pooled	0.046	-0.006	0.097	1.739	0.082
1.00	Augsburger et al., 2022	0.278	0.116	0.440	3.363	0.001
1.00	Blankers et al., 2011	0.462	0.170	0.754	3.101	0.002
1.00	Boß et al., 2018	0.304	0.103	0.505	2.968	0.003
1.00	Bonar et al., 2022a	-0.045	-0.180	0.090	-0.659	0.510
1.00	Bonar et al., 2022b	0.012	-0.323	0.348	0.072	0.942
1.00	Boyle et al., 2022	0.491	0.284	0.699	4.641	0.000
1.00	Brendryen et al., 2014	0.133	-0.117	0.384	1.044	0.297
1.00	Deady et al., 2016	0.106	-0.280	0.493	0.539	0.590
1.00	Donovan et al., 2015	-0.691	-0.917	-0.466	-6.011	0.000
1.00	Geisner et al., 2015	0.240	-0.030	0.511	1.739	0.082
1.00	Gex et al., 2023	0.195	-0.338	0.728	0.718	0.473
1.00	Mello et al., 2008	0.087	-0.081	0.255	1.014	0.311
1.00	Postel et al., 2010	0.956	0.626	1.285	5.679	0.000
1.00	Russell et al., 2022	0.246	-0.143	0.635	1.241	0.215
1.00	Satre et al., 2019	0.030	-0.163	0.222	0.303	0.762
1.00	Schaub et al., 2015	0.238	-0.005	0.481	1.916	0.055
1.00	Schaub et al., 2019	0.439	-0.161	1.039	1.434	0.152
1.00	Sinadinovic et al., 2020	0.152	-0.073	0.377	1.326	0.185
1.00	Wallace et al., 2011	0.000	-0.066	0.066	0.000	1.000
1.00	Walton et al., 2013	0.142	-0.115	0.399	1.083	0.279
1.00	Wirtz et al., 2022	-0.387	-0.766	-0.007	-1.997	0.046
1.00	Wilkiewitz et al., 2014	0.261	-0.197	0.720	1.117	0.264
1.00	Young et al., 2019	0.128	-0.278	0.534	0.618	0.536
1.00	Pooled	0.142	0.062	0.221	3.481	0.000
Overall	Pooled	0.074	0.031	0.117	3.350	0.001

Table H5. Alcohol use at follow-up moderated by relapse prevention (i.e., 0 = no, 1 = yes)

Group by Emotional Regulation &Mental Health Support	Study Name	Statistics for each study				
		Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
0.00	Andersson, 2015	0.077	-0.047	0.201	1.212	0.225
0.00	Arnaud et al., 2016	0.021	-0.081	0.124	0.409	0.682
0.00	Barnett et al., 2007	-0.002	-0.263	0.258	-0.018	0.985
0.00	Bertholet et al., 2015	-0.044	-0.188	0.101	-0.592	0.554
0.00	Braitman et al., 2018	0.020	-0.158	0.198	0.219	0.827
0.00	Cadigan et al., 2019	0.332	-0.013	0.677	1.885	0.059
0.00	Chiauzzi et al., 2005	0.209	-0.058	0.476	1.533	0.125
0.00	Cunningham et al., 2009	0.041	-0.246	0.328	0.280	0.780
0.00	Cunningham et al., 2012	0.207	-0.093	0.507	1.352	0.176
0.00	Delrahim-Howlett et al., 2011	0.118	-0.218	0.453	0.686	0.493
0.00	Doumas et al., 2009	0.064	-0.444	0.571	0.245	0.806
0.00	Doumas et al., 2011	0.239	-0.396	0.874	0.738	0.461
0.00	Freyer-Adam et al., 2018	0.066	-0.078	0.211	0.897	0.370
0.00	Gajecki et al., 2014	-0.122	-0.247	0.003	-1.914	0.056
0.00	Gajecki et al., 2017	0.298	0.031	0.566	2.184	0.029
0.00	Gryczynski et al., 2021	0.171	-0.067	0.409	1.407	0.159
0.00	Hansen et al., 2012	-0.139	-0.278	0.001	-1.948	0.051
0.00	Helzer et al., 2008	-0.336	-0.594	-0.078	-2.548	0.011
0.00	Hester et al., 2009	-0.471	-0.931	-0.010	-2.003	0.045
0.00	Hester et al., 2012 - Study 1	0.358	0.012	0.704	2.027	0.043
0.00	Hester et al., 2012 - Study 2	0.515	0.076	0.954	2.300	0.021
0.00	Ingersoll et al., 2018	-0.169	-0.654	0.316	-0.683	0.495
0.00	Johansson et al., 2021a	0.138	-0.028	0.304	1.627	0.104
0.00	Johansson et al., 2021b	-0.153	-0.433	0.127	-1.071	0.284
0.00	Johnson et al., 2018	-0.056	-0.197	0.084	-0.783	0.434
0.00	Kypri et al., 2009	0.169	0.079	0.259	3.672	0.000
0.00	Kypri et al., 2013	0.165	0.061	0.269	3.096	0.002
0.00	Kypri et al., 2014	0.004	-0.070	0.077	0.098	0.922
0.00	Labrie et al., 2013	0.072	-0.095	0.239	0.843	0.399
0.00	Lee et al., 2021	0.155	-0.196	0.505	0.864	0.387
0.00	Leeman et al., 2016	0.087	-0.299	0.472	0.442	0.659
0.00	Lewis et al., 2014	0.293	0.074	0.512	2.617	0.009
0.00	Liu et al., 2019	0.347	-0.273	0.967	1.098	0.272
0.00	Mason et al., 2014	-0.827	-1.753	0.098	-1.752	0.080
0.00	Murphy et al., 2010	0.591	0.202	0.979	2.981	0.003
0.00	Neighbors et al., 2004	0.155	-0.104	0.415	1.175	0.240
0.00	Neighbors et al., 2010	-0.068	-0.246	0.110	-0.745	0.457
0.00	Rose et al., 2017	0.004	-0.094	0.102	0.079	0.937
0.00	Steers et al., 2016	-0.105	-0.425	0.214	-0.645	0.519
0.00	Strickland et al., 2019	0.021	-0.169	0.211	0.218	0.827
0.00	Suffoletto et al., 2012	-0.556	-1.209	0.097	-1.670	0.095
0.00	Suffoletto et al., 2015	0.016	-0.170	0.201	0.167	0.867
0.00	Teeters et al., 2018	0.102	-0.343	0.548	0.449	0.653
0.00	Tello et al., 2018	-0.055	-0.408	0.298	-0.304	0.761
0.00	Tensil et al., 2013	-0.033	-0.194	0.127	-0.406	0.685
0.00	Van Dessel et al., 2023 - Study 1	-0.115	-0.396	0.167	-0.799	0.424
0.00	Van Dessel et al., 2023 - Study 2	0.050	-0.183	0.282	0.417	0.677
0.00	Voogt et al., 2013a	0.097	-0.034	0.227	1.455	0.146
0.00	Voogt et al., 2013b	-0.058	-0.217	0.101	-0.712	0.477
0.00	Voogt et al., 2014	0.091	-0.039	0.221	1.368	0.171
0.00	Wagener et al., 2012	-0.117	-0.489	0.256	-0.612	0.540
0.00	Pooled	0.046	-0.006	0.097	1.739	0.082
1.00	Augsburger et al., 2022	0.278	0.116	0.440	3.363	0.001
1.00	Blankers et al., 2011	0.462	0.170	0.754	3.101	0.002
1.00	Boß et al., 2018	0.304	0.103	0.505	2.968	0.003
1.00	Bonar et al., 2022a	-0.045	-0.180	0.090	-0.659	0.510
1.00	Bonar et al., 2022b	0.012	-0.323	0.348	0.072	0.942
1.00	Boyle et al., 2022	0.491	0.284	0.699	4.641	0.000
1.00	Brendryen et al., 2014	0.133	-0.117	0.384	1.044	0.297
1.00	Deady et al., 2016	0.106	-0.280	0.493	0.539	0.590
1.00	Donovan et al., 2015	-0.691	-0.917	-0.466	-6.011	0.000
1.00	Geisner et al., 2015	0.240	-0.030	0.511	1.739	0.082
1.00	Gex et al., 2023	0.195	-0.338	0.728	0.718	0.473
1.00	Mello et al., 2008	0.087	-0.081	0.255	1.014	0.311
1.00	Postel et al., 2010	0.956	0.626	1.285	5.679	0.000
1.00	Russell et al., 2022	0.246	-0.143	0.635	1.241	0.215
1.00	Satre et al., 2019	0.030	-0.163	0.222	0.303	0.762
1.00	Schaub et al., 2015	0.238	-0.005	0.481	1.916	0.055
1.00	Schaub et al., 2019	0.439	-0.161	1.039	1.434	0.152
1.00	Sinadinovic et al., 2020	0.152	-0.073	0.377	1.326	0.185
1.00	Wallace et al., 2011	0.000	-0.066	0.066	0.000	1.000
1.00	Walton et al., 2013	0.142	-0.115	0.399	1.083	0.279
1.00	Wirtz et al., 2022	-0.387	-0.766	-0.007	-1.997	0.046
1.00	Wilkiewitz et al., 2014	0.261	-0.197	0.720	1.117	0.264
1.00	Young et al., 2019	0.128	-0.278	0.534	0.618	0.536
1.00	Pooled	0.142	0.062	0.221	3.481	0.000
Overall	Pooled	0.074	0.031	0.117	3.350	0.001

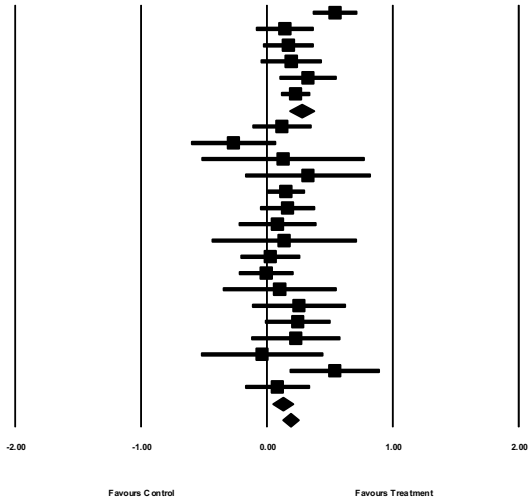


Appendix I

Follow-Up Cannabis Use Outcomes - Moderation Analyses

Table I1. Cannabis use at follow-up moderated by continent (i.e., 0 = Other, 1 = North America)

Group by Continent	Study Name	Hedges's g	Lower limit	Upper limit	Z-Value	p-Value
0.00	Baumgartner et al., 2021	0.541	0.364	0.717	6.005	0.000
0.00	Becker et al., 2014	0.143	-0.087	0.373	1.215	0.225
0.00	Olthof et al., 2023	0.170	-0.031	0.372	1.655	0.098
0.00	Schaub et al., 2015	0.193	-0.050	0.436	1.555	0.120
0.00	Sinadinovic et al., 2020	0.326	0.100	0.553	2.829	0.005
0.00	Tossmann et al., 2011	0.228	0.112	0.344	3.852	0.000
0.00	Pooled	0.274	0.177	0.371	5.539	0.000
1.00	Blow et al., 2017	0.119	-0.115	0.353	0.996	0.319
1.00	Bonar et al., 2022b	-0.266	-0.603	0.071	-1.545	0.122
1.00	Bonar et al., 2023	0.128	-0.520	0.777	0.388	0.698
1.00	Buckner et al., 2020	0.326	-0.172	0.825	1.282	0.200
1.00	Cunningham et al., 2021	0.151	0.001	0.301	1.974	0.048
1.00	Donovan et al., 2015	0.165	-0.055	0.384	1.470	0.142
1.00	Elliott et al., 2014	0.084	-0.224	0.392	0.537	0.591
1.00	Goodness et al., 2020	0.137	-0.439	0.713	0.466	0.641
1.00	Gryczynski et al., 2021	0.027	-0.211	0.264	0.222	0.824
1.00	Lee et al., 2010	-0.005	-0.223	0.212	-0.048	0.962
1.00	Ondersma et al., 2007	0.101	-0.350	0.553	0.440	0.660
1.00	Palfai et al., 2014	0.255	-0.118	0.628	1.341	0.180
1.00	Riggs et al., 2018	0.246	-0.015	0.506	1.848	0.065
1.00	Rooke et al., 2013	0.230	-0.124	0.584	1.273	0.203
1.00	Russell et al., 2022	-0.038	-0.523	0.447	-0.154	0.877
1.00	Schluter et al., 2022	0.539	0.181	0.898	2.952	0.003
1.00	Walton et al., 2013	0.084	-0.173	0.341	0.638	0.523
1.00	Pooled	0.124	0.044	0.204	3.039	0.002
Overall	Pooled	0.185	0.123	0.247	5.871	0.000



Appendix J

Results From the Cochrane Collaboration's Risk of Bias Tool for all Eligible Studies

Study	Randomization Process	Deviations from the Intended Interventions	Missing Outcome Data	Measurement of the Outcome	Selection of the Reported Results	Overall
Agyapong et al., 2012	-	+	+	!	!	-
Andersson et al., 2015	+	+	+	+	-	-
Arnaud et al., 2016	+	+	!	!	+	!
Augsburger et al., 2022	+	+	+	!	!	!
Barnett et al., 2007	+	+	+	!	!	!
Baumgartner et al., 2021	!	+	!	!	-	-
Becker et al., 2014	!	+	!	!	!	!
Bertholet et al., 2015	+	+	+	+	!	!
Bewick et al., 2010	!	-	!	!	!	-
Blankers et al., 2011	!	+	+	+	-	-
Blow et al., 2017	+	-	!	!	-	-
Bob et al., 2018	+	+	+	!	+	!
Bonar et al., 2022a	+	+	+	!	-	-
Bonar et al., 2022b	-	-	!	+	!	-
Bonar et al., 2023	!	-	!	!	-	-
Boyle et al., 2022	+	-	!	+	+	-
Braitman et al., 2018	-	+	!	!	!	-
Brendryen et al., 2014	+	+	!	!	!	!
Buckner et al., 2020	+	-	!	!	!	-
Butler et al., 2009	!	-	!	!	!	-
Cadigan et al., 2019	!	!	+	!	!	!
Chiauzzi et al., 2005	!	+	!	+	!	!
Cunningham et al., 2009	-	+	!	!	-	-
Cunningham 2012	+	+	!	+	!	!
Cunningham et al., 2021	+	+	+	+	!	!
Deady et al., 2016	+	+	!	!	+	!
Delrahim-Howlett et al., 2011	+	-	!	+	!	-
Donovan et al., 2015	+	+	!	!	!	!
Doumas et al., 2009	+	-	!	!	!	-
Doumas et al., 2011	-	-	!	!	!	-
Elliot et al., 2014	!	+	+	!	!	!
Freyer-Adam et al., 2018	-	-	!	!	!	-
Gajecki et al., 2014	+	+	!	!	!	!
Gajeck et al., 2017	+	-	!	!	!	-

Study	Randomization Process	Deviations from the Intended Interventions	Missing Outcome Data	Measurement of the Outcome	Selection of the Reported Results	Overall
Geisner et al., 2015	!	+	!	!	!	!
Gex et al., 2023	!	-	!	!	!	-
Goodness et al., 2020	!	-	!	!	!	-
Gryczynski et al., 2021	+	+	!	!	!	!
Hansen et al., 2012	+	+	!	!	-	-
Helzer et al., 2008	!	-	!	!	!	-
Hester et al., 2009	!	+	!	!	!	!
Hester et al., 2012	+	-	!	!	!	-
Ingersoll et al., 2018	!	+	!	!	!	!
Johansson et al., 2021a	+	+	!	+	!	!
Johansson et al., 2021b	+	+	!	+	!	!
Johnson et al., 2018	+	+	+	+	!	!
Kypri et al., 2009	+	+	+	+	!	!
Kypri et al., 2013	+	+	+	+	+	+
Kypri et al., 2014	+	+	!	+	!	!
LaBrie et al., 2013	+	-	+	!	!	-
Lee et al., 2010	+	+	+	!	!	!
Lee et al., 2021	!	+	+	!	!	!
Leeman et al., 2016	!	+	!	!	!	!
Lewis et al., 2014	!	+	!	!	!	!
Liu et al., 2019	+	-	!	+	!	-
Mason et al., 2014	-	!	+	!	!	-
Mello et al., 2008	+	+	+	!	!	!
Muench et al., 2017	+	+	!	+	!	!
Murphy et al., 2010	+	-	!	!	!	-
Neighbors et al., 2004	!	-	+	!	!	-
Neighbors et al., 2010	+	-	!	!	!	-
Olthof et al., 2023	+	+	+	+	+	+
Ondersma et al., 2007	+	+	!	!	!	!
Palfai et al., 2014	!	-	!	!	!	-
Postel et al., 2010	+	+	!	!	!	!
Riggs et al., 2018	!	-	+	!	!	-
Rooke et al., 2013	-	+	+	!	!	-
Rose et al., 2017	!	+	!	+	!	!
Russell et al., 2022	!	!	+	!	!	!
Satre et al., 2019	+	!	+	!	-	-
Schaub et al., 2015	-	+	!	!	!	-

Study	Randomization Process	Deviations from the Intended Interventions	Missing Outcome Data	Measurement of the Outcome	Selection of the Reported Results	Overall
Schaub et al., 2019	!	-	!	!	!	-
Schluter et al., 2022	+	+	+	!	!	!
Sinadinovic et al., 2020	+	+	!	+	!	!
Steers et al., 2016	!	-	!	!	!	-
Strickland et al., 2019	!	-	!	!	-	-
Suffoletto et al., 2012	+	-	!	!	!	-
Suffoletto et al., 2015	+	+	!	+	!	!
Sundström et al., 2020	+	+	!	+	!	!
Teeters et al., 2018	-	+	!	!	!	-
Tello et al., 2018	!	!	+	!	+	!
Tensil et al., 2013	+	+	!	+	!	!
Tossman et al., 2011	+	+	!	!	!	!
Van Dessel et al., 2023	+	+	!	+	+	!
Voogt et al., 2013a	+	+	!	!	-	-
Voogt et al., 2013b	+	+	!	+	+	!
Voogt et al., 2014	+	+	!	!	-	-
Wagener et al., 2012	!	!	+	!	!	!
Wallace et al., 2011	+	+	!	+	+	!
Walton et al., 2013	+	+	!	!	-	-
Wirtz et al., 2022	+	+	!	!	!	!
Witkiewitz et al., 2014	!	+	!	!	!	!
Young et al., 2019	!	-	!	!	!	-

Note: + = Low risk; ! = Some risk; - = High risk; Overall risk of bias scores were determined based on criteria outlined by Sterne et al. (2019)

Appendix K
Underpowered Analysis of BEAM ARSU+ versus TAU ARSU+

Table K2. At-risk substance use group treatment response between BEAM and treatment as usual

	Anxiety Estimate (*SE*)	**Depression Estimate (*SE*)**	**Anger Estimate (*SE*)**	**Sleep Disturbance Estimate (*SE*)**	**Parenting Stress Estimate (*SE*)**	**Mental Health Composite Estimate (*SE*)**
Random effects						
Intercept	**11.76 (3.45)***	**15.35 (3.58)*****	2.72 (1.73)	**26.47 (5.24)*****	**21.89 (10.07)***	0.03 (1.62)
Time	0.76 (0.70)	0.15 (.82)	**0.90 (0.33)****	0.94 (1.01)	0.45 (1.47)	1.52 (1.34)
Fixed Effects						
Intercept	**16.00 (2.83)*****	**17.40 (3.03)*****	**18.47 (1.79)*****	**31.16 (3.36)*****	**21.52 (3.59)*****	-0.44 (1.32)
Time	-2.40 (1.41)	**-2.82 (1.27)***	-0.89 (0.98)	-2.42 (1.43)	0.05 (1.73)	0.93 (1.06)
Trial	0.93 (2.41)	0.14 (2.40)	0.60 (1.43)	0.62 (2.80)	-0.07 (2.75)	0.60 (0.67)
Interaction Effects						
Trial on time	-0.44 (1.27)	-.09 (1.05)	-0.57 (0.83)	-0.07 (1.22)	-0.61 (1.45)	-0.52 (0.53)

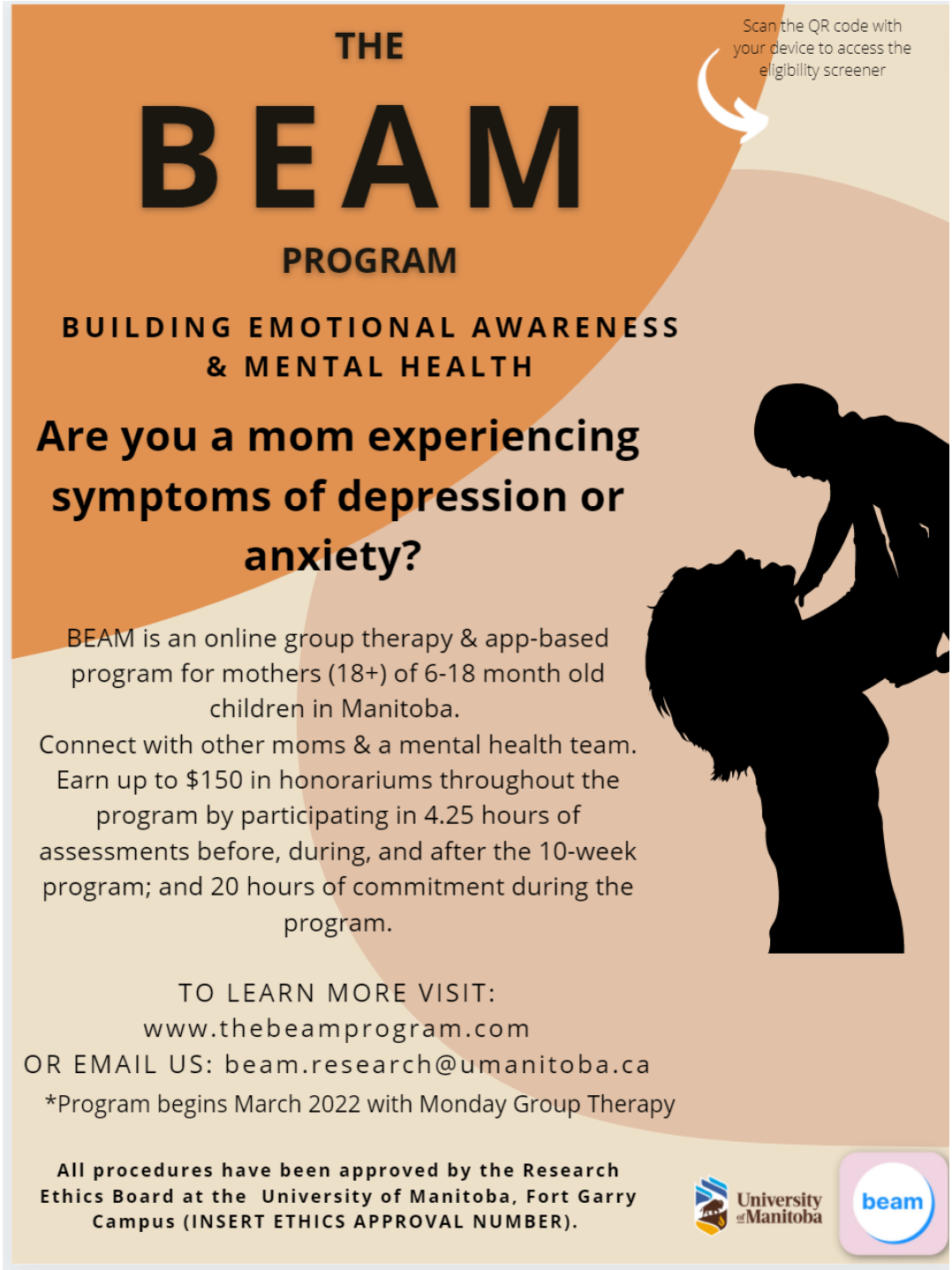
Note: Significant results are bolded; *SE* = standard error
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table K2. At-risk substance use group treatment response by BEAM and treatment as usual, moderated by enrollment (T0) symptom severity

	Anxiety Estimate (*SE*)	**Depression Estimate (*SE*)**	**Anger Estimate (*SE*)**	**Sleep Disturbance Estimate (*SE*)**	**Parenting Stress Estimate (*SE*)**	**Mental Health Composite Estimate (*SE*)**
Random effects						
Intercept	4.32 (2.80)	**10.16 (3.25)****	1.08 (1.45)	**19.71 (5.47)*****	**22.41 (10.01)***	0.03 (1.62)
Time	1.19 (0.72)	0.26 (0.73)	**0.90 (0.35)***	1.32 (1.02)	0.36 (1.48)	1.49 (1.30)
Fixed Effects						
Intercept	**16.84 (2.66)*****	**18.39 (2.50)*****	**18.89 (1.74)*****	**31.95 (3.30)*****	**21.26 (3.60)*****	-0.52 (1.43)
Time	-2.47 (1.40)	**-2.99 (1.15)****	**-0.91 (0.98)**	-2.56 (1.44)	**0.14 (1.74)**	0.99 (1.12)
Trial	0.24 (2.38)	-0.63 (1.95)	0.24 (1.40)	-0.03 (2.91)	0.13 (2.73)	0.66 (0.75)
Symptom Severity[a]	**18.15 (3.97)*****	**22.87 (4.35)*****	**7.63 (3.15)***	**17.92 (4.70)*****	-3.93 (6.64)	-1.19 (2.05)
Interaction Effects						
Trial on Time	-0.37 (1.27)	0.02 (0.94)	-0.54 (0.82)	0.05 (1.25)	-0.66 (1.45)	-0.55 (0.57)
Symptom Severity on Time	2.21 (3.63)	-2.10 (3.87)	0.56 (2.38)	2.40 (5.48)	5.38 (4.45)	2.72 (2.40)
Trial * Symptom Severity on Time	-3.58 (2.33)	-2.58 (2.69)	-0.48 (1.28)	-4.54 (3.52)	-2.60 (3.07)	-1.05 (0.66)

Note: [a]Collected at enrollment; Significant results are bolded; *SE* = standard error
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Appendix L
Recruitment Poster



Appendix M
Substance Use Questionnaires

Infant Trial	
On days when you use cannabis, how much of the following cannabis products do you use (in the past month)?	a) One smoked cannabis product (one product means 0.5 grams of dried cannabis, five bong or pipe hits, or 10 puffs of a joint) b) One edible or dose of oils containing 10 mg THC
Do you currently use or smoke tobacco products?	1) No 2) Yes 3) Prefer not to answer
Do you currently use illicit drugs? (cocaine, methamphetamines, opioids, prescription medication not prescribed to you, etc.)	1) No 2) Yes 3) Prefer not to answer
Toddler Trial	
On days when you use cannabis, how much of the following cannabis products do you use (in the past month)?	a) One smoked cannabis product (one product means 0.5 grams of dried cannabis, five bong or pipe hits, or 10 puffs of a joint) b) One edible or dose of oils containing 10 mg THC
In the past month, how many days did you use tobacco products?	Open Text
In the past month, how many days did you use illicit drug products?	Open Text

Appendix N
Online Risk-Management Policies and Procedures

University of Manitoba Online Intervention:
Building Emotional and Mental wellness (BEAM)

Online Risk-Management Policies and Procedures

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Table of Contents

In this setting, telehealth or telepsychology (used variably) primarily refers to online and mobile app-based psychotherapy, including online psychoeducation videos, support group forums moderated by psychology experts, online psychological assessment, real-time video conferencing and other electronically mediated aspects of mental health services.

Telepsychology COVID-19 Policies

- Participants will complete an online intake assessment on REDcap to confirm that they are 18 years of age or older, that they have a child between the ages of 2–3 years old, and that they are experiencing moderate-to-severe depression symptoms based on PHQ-9 scores.
    - Mothers will be randomized with an online randomization tool) to either the treatment or wait-list control group
- Psychoeducation videos and support group forums are offered via mobile app and website, designed by Tactica Interactive, and will be conducted free of charge.
- Clinical topic experts will provide weekly 20-30-minute video lessons with opt-in videos for specific family needs (e.g., insomnia, domestic conflict).
- Each cohort will participate in a closed online community forum consisting of 20-40 mothers mediated by a mental health clinician. Rules and Terms of Use can be found on page 4.
- Online bi-weekly assessment services will be offered via REDcap for PHIA compliance
    - These assessments will include:
        - Weekly 2-minute surveys to assess depression beginning at study enrolment (week 0) and continuing for 10 weeks following the end of program content until week 18
        - Three 45-minute assessments at pre (week 0), post (week 10), and follow-up (week 18) time points will assess the extent to which stress and parenting mechanisms correlate with observed changes in child behaviour and maternal mental health

BEAM: Rules and Terms of Use of Social Forums

The online community portion encourages a supportive group of mothers who will move through the program with you! In each of the communities there will be a peer and a clinical coach.

The forums include semi-structured discussion topics. The peer coaches are mothers who have sought support for their own mental health & parenting needs and are interested in being part of a mental wellness while parenting community.

By joining, we ask that all clients agree to not post the following information. Posting on these topics may be upsetting to other participants or violate University of Manitoba data agreements. Should you need to discuss any of these areas with your clinical coach, you are welcome to contact them via email.

By clicking this box, I agree to refrain from posting on the following topics:

1. Personal information that could identify you to group members, including:
    a. Address
    b. Phone number
    c. Other personal/demographic information
2. Substance use OR Self-harm OR suicidal behaviours
    a. If you are experiencing any of the following, please email your please clinical coach, who will provide further support.
        i. distressing suicidal thoughts, plans or are actively self-harming
        ii. alcohol, marijuana, or substance use that is impacting your daily function and you are having difficulty controlling.
3. Personal health information including:
    a. Medical diagnoses
    b. Test and laboratory results
    c. Insurance information
    d. Mental health diagnoses
4. Spam/advertising/self-promotion in the forums
    a. These forums define spam as unsolicited advertisement for goods or services.
5. Copyright-infringing materials
    a. Providing or asking for information on copyrighted materials is forbidden
6. Offensive posts, links or images
    a. Any materials that constitute defamation, harassment, or abuse
    b. Material that is sexually or otherwise obscene, racist or otherwise discriminatory
7. Disrespectful comments towards other group members
    a. All posts should be respectful and courteous.
    b. Any instance threatening, harassing, or discriminatory behaviour is grounds for you to be denied access to the forum.

Critical Incident Protocol and Report Procedures

I. High Risk Situations

If any person, child or adult participating in the program is in ***immediate danger***, the following steps will be followed:

1. Call 911 if there is immediate danger and provide local 911 call with client name, address, phone number and the nature of the concern
2. Call Dr. Roos and of Clinical Team Co-Is to inform them of the situation
3. Document the situation, on the High-Risk Situation Form
4. Dr. Roos and the Clinical Team Co-Is, will consult to decide whether or not the participants should continue in the study. If it is decided that program participation will be terminated Dr. Roos will inform the family and follow-up with additional support services, including short-term telehealth therapy, if needed.

If any clinical team member has reason to believe a child may be experiencing maltreatment or endangerment the following steps will be followed:

1. Call Dr. Roos and of Clinical Team Co-Is to inform them of the situation and consult
2. Determine if any clarifying questions need to be asked or if a CPS report should be filed immediately. If clarity is needed:
    1. Communicate concern to client and ask the minimum number of clarifying questions (per in consultation) to determine if situation meets threshold for reporting to CPS.
3. Contact CPS or non-emergency police in clients postal code region if meets threshold OR decide not to contact CPS based on available information
4. Document the situation, on the High-Risk Situation Form
5. Dr. Roos and the Clinical Team Co-Is, will consult to decide whether or not the participants should continue in the study. If it is decided that program participation will be terminated Dr. Roos will inform the family and follow-up with additional support services, including short-term telehealth therapy, if needed.

i. High Risk Situation Form

To be completed by anyone in the lab who encounters a high-risk dangerous situation.

Participant ID: _____

Date: _____

Form filled out by: _____

What happened? In as much detail as you can, clearly describe what happened leading up to and during the dangerous situation. Include the ***Who, What,*** and ***When***. Describe what actions you took during the situation.

What will happen next? Describe who you have notified, what safety precautions will be taken and next step plans.

Signature: _____ Date: _____

Have additional steps been taken since this form was originally completed?

Team Member Initials: _____ Clinical Supervisor Initials: _____

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The next section is to be completed by a clinical team lead

Provide a brief summary of the events surrounding the incident and a summary of the additional steps (if any) that have been taken since this document was first completed.

Signature: _____ Date: _____

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II. Suicidal Thoughts/Behaviors

Because the mothers we will be working with will be diagnosed with depression, we anticipate that some mothers may be experiencing and/or express suicidal thoughts, behaviors, or non-life-threatening self-injury.

- Situations in which we might become aware of suicidal thoughts/behaviors
  ii. Bi-weekly Assessments
  iii. Email to clinical coach

i. Bi-weekly Assessment

- *Questions that Ask About Suicidal Thoughts and Behaviours*

During the assessments, mothers will be asked questions specifically about their experiences with suicidal thoughts and behaviors.

The following assessments and items ask about suicide:

- Patient Health Questionnaire (PHQ)
  - Item 9 (mother responds with 2, or 3
  - REDcap will initiate an immediate contact to the clinical team to notify them if a participant endorse a 2 or 3 on the PHQ-9

ii. Message to clinical coach

- *Participant Voluntarily Discloses Information About Suicide*
  - Although unlikely, participants might disclose information about their suicidal thoughts, behaviors, and self-injury to their clinical coach, but not endorse these responses in the PHQ 9 at the threshold level.

Should either of these events occur:

(1) If there is clear imminent danger (see immediate danger section, above)
(2) If more information is needed: consult with the clinical team immediately and contact the client to have a phone call as soon as possible.
(3) Conduct a semi-structured suicide risk assessment via Zoom Healthcare or phone to determine risk, a safety plan, and next steps
(4) Complete a High-Risk Situation Form

** Note – All clinical practices linked to risk assessments are considered within the scope of the clinical team's responsibility and will not become part of the research record or linked to their ID numbers.

Appendix O
Full Model Results When Covariates are Added

Table N1. At-risk substance use group treatment response

	Anxiety Estimate (*SE*)	**Depression Estimate (*SE*)**	**Anger Estimate (*SE*)**	**Sleep Disturbance Estimate (*SE*)**	**Parenting Stress Estimate (*SE*)**	**MH Comp. Estimate (*SE*)**
Random effects						
Intercept	**10.65 (2.87)*****	**11.60 (3.10)*****	1.19 (1.20)	**21.61 (4.70)*****	**17.06 (5.95)****	**0.01 (0.00)****
Time	0.44 (0.56)	0.96 (0.69)	**1.15 (0.31)*****	1.31 (1.01)	0.96 (1.22)	**0.00 (0.00)*****
Fixed Effects						
Intercept	**16.25 (1.17)*****	**16.18 (1.09)*****	**18.98 (0.63)*****	**29.74 (1.30)*****	**20.57 (1.39)*****	**0.73 (0.03)*****
Time	**-3.28 (0.61)*****	**-3.12 (0.57)*****	**-1.50 (0.41)*****	**-2.01 (0.71)****	-0.88 (0.64)	**-0.10 (0.02)*****
Employed	-0.89 (0.59)	-0.19 (1.51)	-0.41 (0.42)	-0.20 (0.71)	0.60 (0.66)	-0.03 (0.02)
Breast/Chest Feeding	-0.39 (1.53)	-0.91 (0.55)	-0.66 (0.86)	2.12 (1.73)	-0.76 (1.67)	0.00 (0.04)
ARSU	0.85 (1.58)	0.26 (1.58)	0.69 (0.90)	1.41 (1.65)	-0.84 (1.69)	0.04 (0.04)
Interaction Effects						
Employed on Time	0.88 (0.59)	0.90 (0.55)	0.41 (0.42)	0.20 (0.71)	-0.59 (0.66)	0.03 (0.02)
Breast/Chest Feeding on Time	-0.11 (0.64)	-0.11 (0.64)	0.11 (0.44)	-0.85 (0.72)	0.60 (0.68)	-0.01 (0.02)
ARSU on Time	-0.14 (0.70)	0.08 (0.68)	-0.52 (0.50)	-0.99 (0.73)	0.76 (0.85)	0.02 (0.02)

Note: Employment and breast/chest feeding were added the model; *SE* = standard error
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table N2. At-risk substance use group treatment response, moderated by enrollment (T0) symptom severity

	Anxiety Estimate (*SE*)	**Depression Estimate (*SE*)**	**Anger Estimate (*SE*)**	**Sleep Disturbance Estimate (*SE*)**	**Parenting Stress Estimate (*SE*)**	**MH Comp. Estimate (*SE*)**
Random effects						
Intercept	**6.16 (2.96)***	4.94 (2.72)	0.20 (1.02)	**17.74 (4.54)*****	**15.18 (6.04)***	0.00 (0.00)
Time	0.70 (0.57)	**1.50 (0.69)***	**1.17 (0.35)****	1.66 (1.0)	1.02 (1.20)	**0.00 (0.00)****
Fixed Effects						
Intercept	**16.77 (1.11)*****	**17.10 (1.06)*****	**19.18 (0.71)*****	**30.40 (1.32)*****	**20.77 (1.51)*****	**0.75 (0.03)*****
Time	**-3.19 (0.62)*****	**-3.28 (0.62)*****	**-1.39 (0.47)****	**-2.12 (0.77)****	-0.84 (0.73)	**-0.10 (0.02)*****
Employed	-0.65 (0.55)	-0.91 (0.57)	-0.27 (0.47)	-0.17 (0.73)	0.60 (0.73)	-0.02 (0.01)
Breast/Chest Feeding	-0.83 (1.40)	-0.73 (1.25)	-0.87 (0.83)	1.69 (1.62)	-0.89 (1.71)	-0.01 (0.03)
Symptom Severity	**16.51 (4.44)*****	**22.86 (3.51)*****	**7.08 (2.79)***	**15.72 (4.48)*****	6.15 (4.77)	**0.60 (0.10)*****
ARSU	-0.61 (1.39)	-1.69 (1.39)	0.11 (0.89)	-0.01 (1.67)	-1.28 (1.81)	-0.01 (0.02)
Interaction Effects						
Employed on Time	0.64 (0.55)	0.90 (0.57)	0.27 (0.47)	-0.16 (0.73)	-0.60 (0.73)	0.02 (0.01)
Breast/Chest Feeding on Time	-0.07 (0.64)	0.01 (0.60)	0.11 (0.44)	-0.78 (0.69)	0.63 (0.69)	-0.01 (0.02)
ARSU on Time	-0.03 (0.68)	0.50 (0.68)	-0.52 (0.51)	-0.80 (0.80)	0.88 (0.93)	-0.01 (0.02)
Symptom Severity on Time	-2.34 (2.42)	-3.50 (2.40)	-0.09 (1.62)	-3.08 (2.94)	0.72 (2.24)	-0.09 (0.02)
ARSU * Symptom Severity on Time	0.48 (2.48)	-3.31 (2.52)	-0.87 (1.51)	1.17 (3.73)	-4.64 (2.60)	-0.02 (0.07)

Note: Employment and breast/chest feeding were added the model; *SE* = standard error
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.