The Use of Non-Commercial Parent-Focused mHealth Interventions for Youth Behavior Problems: A Systematic Review

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Abstract

Background: Adolescent substance use rates are staggering, and current treatment options are often lacking integration of parent-focused interventions, despite evidence that effective parenting practices can mediate adolescent substance use treatment outcomes. Accessibility challenges and other barriers to parental interventions may be mitigated through mHealth; however, there are few mHealth platforms that target adolescent substance use through the implementation of behavioral parent training strategies.

Objective: The present study seeks to review current mHealth platforms within empirical literature designed to increase effective parenting through behavioral parent training techniques. Because of the paucity of mHealth modalities that target adolescent substance use through parenting strategies, this study adapted to review mHealth platforms that address child behavior problems as parent-targeted treatment for these clinical presentations overlap with those of adolescent substance use. Overall, the systematic review was conducted to inform future development of parent-focused mHealth apps for parents of youth engaged in substance misuse, improve accessibility, and align with parental needs and desires for treatment.

Methods: A systematic review was conducted using the PRISMA method across several databases. Each study was assessed for relevance and the determined inclusion criteria. Once identified as appropriate for inclusion, each study was reviewed for demographics, medium of delivery, standalone or enhancement to treatment, mobile device used, mental health condition, intervention used, theory of intervention, theory of behavior change in design, behavior change techniques, parent training techniques, youth outcomes, parent outcomes, visual design, content, and features.

Results: Demographics ranged across studies. Most studies integrated social learning theory. Few studies discussed behavior change theories embedded in the mHealth treatment content; however, many studies described behavior change techniques utilized to encourage change in parental behaviors. Many mHealth studies tailored design features to the end user and integrated varying behavioral parent training techniques. Visual design was rated for studies that provided an image of the mHealth layout. Preliminary evaluation of treatment outcomes suggests positive impact of parent-targeted mHealth interventions for youth and parents.

Conclusions: While features and techniques are references, few studies provide specific information related to behavior change theory, visual design, and translation of parent-targeted interventions to mHealth platforms. Such information would be useful for the development of future mHealth applications. Preliminary youth and parent outcomes are encouraging, though future studies should consider a meta-analysis as the studies expand to determine aggregate statistical findings. Additional future directions, limitations, and strengths are discussed.

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Objective: The present study seeks to review current mHealth platforms within empirical literature designed to increase effective parenting through behavioral parent training techniques. Because of the paucity of mHealth modalities that target adolescent substance use through parenting strategies, this study adapted to review mHealth platforms that address youth behavior problems given that parent-targeted treatment for these clinical presentations overlap with that of adolescent substance use. Overall, the systematic review was conducted to inform development of mHealth apps for parents of youth engaged in substance misuse, improve accessibility, and align with parental needs.

Methods: A systematic review was conducted using the PRISMA method across several databases. Each study was assessed for relevance and inclusion. Each study was reviewed for demographics, medium of delivery, standalone or enhancement to treatment, mobile device used, mental health condition, intervention used, theory of intervention, theory of behavior change in design, behavior change techniques, parent training techniques, youth outcomes, parent outcomes, visual design, content, and features.

Results: Eleven studies were included. Nearly all studies (n=9) predominantly sampled from female caregivers. Most studies (n=6) integrated social learning theory. Few studies discussed behavior change theories embedded, whereas many studies used behavior change techniques to encourage change in parental behaviors. Many studies tailored design features to the end user (n=7). Of the varying behavioral parent training techniques, nearly all studies included the skill of strengthening the parent-child relationship (n = 10). Preliminary evaluation of treatment outcomes suggests positive impact of parent-targeted mHealth interventions. When reported, effect sizes for treatment ranged for youth (d=0.38 to d=1.58) and parents (d = 0.13 to 2.59).

Conclusions: While features and techniques are references, few studies provide specific information related to behavior change theory, visual design, and translation of parent-targeted interventions to mHealth platforms. Such information would be useful for the development of mHealth applications. Preliminary youth and parent outcomes are encouraging, though future studies should consider a meta-analysis as the studies expand to determine aggregate statistical findings.

Keywords: Behavioral parent training; mHealth; mobile application; adolescent substance use; child mental health condition

Introduction

Adolescent substance use occurs at alarming rates in the United States, with approximately 4.3

million youth using illicit substances in 2019 [1]. Despite evidence indicating that 1.1 million of these youth needed substance use treatment, less than 1% of these adolescents obtained treatment [1]. For the few youths who receive substance use treatment, parent-focused interventions, shown to improve parenting practices that mediate adolescent outcomes, are often a missing component [2,3,4]. This is concerning because there are limited resources and pathways of access for parents of substance-using adolescents to receive parenting resources or support [5,6,7].

This inability to access parent-focused interventions may be related to both a lack of availability of these interventions [8,9] and logistical, personal, or systemic barriers to treatment engagement [10,11,12,13,14,15]. Nonetheless, less frequently acknowledged is that the currently available treatment options for parents of substance-using adolescents may not embody the type of treatment that these parents desire. Recent research showed that, among a sample of parents with youth in treatment for substance use, the majority (72%) perceived a need for parent-focused services related to parenting their adolescent after their child's substance use treatment [16]. When aftercare was offered via mobile phone, this number increased to 91% of parents reporting the desire for parent-focused aftercare [16]. One interpretation of these findings is that parents are not currently receiving support through a desired medium.

Taken together, there is a need for greater access to strategies for engaging in effective parenting of children with a history or substance use, and leveraging mHealth may help address this service gap. Unfortunately, the development of mHealth apps is moving at a rapid pace in most areas of health care except adolescent substance use [17]. There is one published study of an mHealth app for parents of youth involved with substances [18]. However, this app focuses on delivering mindfulness and excludes a focus on behavioral parent training. Given the demonstrated benefits of behavioral parenting approaches in curtailing adolescent substance use [4,19] and the potential advantages that mHealth apps have in broadening access and reach, it is surprising that more attention has not been paid to developing a mHealth intervention specifically for parents of youth with substance misuse.

The current systematic review sought to evaluate mHealth apps in the empirical literature designed to increase effective parenting through behavioral parent training techniques for child behavior problems. Given the overlap in behavioral parent training interventions for behavior problems and substance misuse [20,21,22,23], the results of this review could inform the development of future parent-focused mHealth apps for parents of youth engaged in substance misuse, improving accessibility, and matching parental desires for treatment mediums [24,25].

Background

Behavioral Parenting and Adolescent Substance Use

Parenting practices shape the development and outcome of a child [26]. The literature is replete with results showing ineffective parenting practices like poor monitoring/supervision, inconsistent discipline, poor limit setting, and low positive parenting are associated with a range of behavior problems [27], including substance use disorders [28, 29]. Based on the plethora of research demonstrating the importance of parenting practices, evidence-based treatments designed to treat adolescent behavior problems, including substance use, are heavily steeped in addressing ineffective parenting with the use of behavioral parent training

[20,22]. Broadly, behavioral parent training is an evidence-based approach to helping parents apply behavioral strategies to improve their child's behavior and increase positive family interactions and is also referred to as parent management training and parenting training [30].

mHealth Apps for Behavioral Parenting Training

Following a literature review, Jones and colleagues [31] concluded that behavioral parent training is a strong fit for transfer to technological mediums such as smartphone applications. We concur with this position and argue that behavioral parenting training is compatible for translation to mHealth because key parenting strategies that comprise behavioral parenting training protocols can be aided with smartphone apps such that design features may tap into general principles of behavior change to promote parenting behaviors. Specifically, app features such as routine prompts and timely notifications with tips may promote consistent implementation of rules and facilitate limit setting and use of consistent discipline. In fact, prompting through push notifications aligns with behavioral change theories within mHealth that emphasize reminders to enact skills and integration of encouragement [32,33] to foster steadfast use of learned, effective parenting practices. For example, this use of encouragement may include periodic messages that remind parents of a learned parenting skill and encourage them to continue using the skill.

Objectives

The original aim of the present study was to systematically review available non-commercial mHealth apps for parents of youth engaged in substance use. The literature related to mHealth apps that focus on providing parental intervention to target adolescent substance use is very limited. The paucity of studies rendered a systematic review of parent-targeted mHealth apps for adolescent substance use very challenging. In an effort to continue to explore and review this subject in the landscape of limited research, the objective of the present study expanded. In particular, the present study slightly shifted to a systematic review of mHealth apps that focus on providing behavioral parent training or components of behavioral parent training to enhance use of effective parenting for youth behavior problems. This shift broadened the search for current mHealth apps in the literature, while also maintaining relevancy and generalization for intervening on adolescent substance use through parent-targeted mHealth interventions. More specifically, the behavioral parenting interventions that are implemented to target youth behavioral problems significantly overlap with those used to intervene on adolescent substance use. The large overlap in treatment content may be related to the notion that adolescent substance use is often treated within a youth behavioral problem lens [20,21,22,23]. Therefore, the results of this review could generalize to the development of future parent-focused mHealth apps for parents of youth engaged in substance misuse [24,25]. The present study sought to answer four main research questions:

(1) What are the general characteristics of behavioral parent training apps under development?

(2) What is the empirical evidence underlying behavioral parent training apps under development?

(3) What are the main parenting strategies covered in behavioral parenting training apps under development?

(4) What implications do the characteristics, empirical evidence, and parenting strategies evidenced in current behavioral parent training apps have on the development for an mHealth app for parents of youth with behavioral problems engaged in substance misuse? To answer these objectives , we summarize the major design, features, content, and theoretical foundation of the apps evaluated, and parallel these features with the components of substance use treatment to provide recommendations for the design of mHealth Apps for parents of adolescents who use substances. In contrast to existing studies, these objectives enhance knowledge about apps tailored specifically for parents of adolescents who use substances.

While prior studies have reviewed mHealth apps for behavior change theory and techniques, these reviews included a narrow focus on these factors [33,34,35] not a review of behavioral parenting practices. Some studies have reviewed commercial parenting apps [17,36] or apps for specific groups of parents (e.g., low-income fathers and new parents [36,37,38]), or apps for parents with adult children [39]. However, these studies did not review apps designed to teach behavioral parenting skills to address child behavior problems. Indeed, several reviews provide information about the effectiveness of technology-based interventions for behavior change and parents of children with emotional or behavioral issues [40,41,42]. However, these reviews included a mix of dated mediums alongside mHealth apps, including websites, software, video-conferencing services, and text messaging.

Methods

Literature Search

A systematic search of research studies was conducted following the PRISMA method [43,44] (see Figure 1). This review was conducted without financial support. This process was conducted electronically in the English language between June and September of 2019, again in March 2021, and again in October 2022. No restrictions on the date or year of article dissemination were made in the original 2019 search, and the 2021 and 2022 searches were limited to materials published in the time since the prior searches. The following databases were employed: PsychINFO, MEDLINE (PubMed), Google Scholar, Scopus, Web of Science, and WorldCat. References from selected articles and past literature review articles were also examined to identify potential sources that may have met criteria for this review [39,40,45,46].

The following mobile technology search terms were used: mobile phone, mHealth, eHealth, SMS, text messaging, mobile application, tablet, smartphone, and cell phone. The following parent treatment search terms were used: parent training, intervention, treatment, parent management training, parent-child interaction, behavioral training. The following mental health search terms were used: behavior, attention deficit/hyperactivity disorder, autism spectrum disorder, posttraumatic stress disorder, trauma, psychological, and disorders. These terms were entered into databases using various search combinations including: (mobile phone OR cell phone OR smartphone OR tablet) AND (parent train* OR treat* OR parent management train*) AND (behav* OR trauma OR disorder OR attent* OR psycholog* OR autism) AND (SMS* OR text messag* OR application OR mHealth OR eHealth).

The search conducted in October 2022 to update results utilized the original search terms with date restricted to the years since the search conducted in March 2021 (i.e., 2021-2022). In the search update, searches in three databases were modified to limit the number of results for relevancy. Specifically, in MEDLINE (PubMed), the search was limited to clinical trials and

randomized control trials, in Scopus results were limited to articles, and in Web of Science, the additional search criteria of "adol* OR child* OR parent* OR caregiver OR mother OR father OR youth" was used to reduce many irrelevant results.

Study Selection and Eligibility Criteria

Titles and abstracts identified from the search process included both peer-reviewed feasibility or acceptability articles, and conference proceedings, due to the paucity of studies in this field. Articles were screened against the following inclusion criteria by three reviewers (SRP, KM, KL) independently conducted the search and met afterwards to integrate search results; such that decisions about inclusion and exclusion for each record were made jointly by all three reviewers. Articles were screened against the following inclusion criteria:

(1) the study investigated parent-targeted interventions to influence child mental health conditions (defined as the presence of adverse behavioral and emotional symptoms that may be contributing to psychological difficulties). These conditions may include disruptive behaviors and/or conduct disorder symptoms, substance use, attention-deficit/hyperactivity disorder symptoms, trauma symptoms, and autism spectrum disorder symptoms; however, developmental, language, speech, and/or motor delays are excluded as these may not always be directly related to one's psychological symptoms;
(2) the study provided data on efficacy or effectiveness of the intervention
(3) the study provided data on either parental or child outcomes
(4) interventions only employed the use of mobile device or tablet (studies were excluded if involved utilization of websites or computers at any capacity)
(5) intervention content, such as specific parenting skills, was delivered via text messaging and/or mobile applications (as opposed to professionals disseminating interventions via mobile devices)
(6) either standalone treatment or enhancement to existing treatment were included if intervention involved more than simple reminders to attend regular treatment, *under the rationale that even enhanced treatment components may serve as standalone interventions with further research development*
(7) biological parents, non-biological parents, and foster caregivers were included
(8) interventions targeting parents of children ranging in ages 2-18, under the rationale that regardless of developmentally different manifestation, basic principles of certain effective parenting practices are the same (e.g., parental monitoring)
(9) articles or conference papers in English language

Identification and Description of Study Characteristics

Study Characteristics Assessed

Each article selected for the review was assessed for various characteristics, including demographics, medium of delivery, standalone or enhancement to treatment, mobile device used, mental health condition, intervention used, theory of intervention, theory of behavior change in design, behavior change techniques, parent training techniques, youth outcomes, parent outcomes, visual design, content, and features. Each of these characteristics was operationalized according to the present review's context (Table 1).

These characteristics were first assessed through careful reading of each article by the lead author (KM). If elements could not be identified through reading the article, references of the article were reviewed to determine if preliminary work contained them. Authors from two

studies were contacted to determine if further research surrounding the initial study had been conducted, and one of the authors responded. For behavior change techniques, visual design qualities, content, and theoretical foundations, the following methodologies were used. The present systematic review was not registered, and a formal study protocol is not accessible.

Table 1. Operationalization of characteristics and features reviewed.

	Operationalization
Medium of Delivery	The method in which the intervention was delivered on the mobile device, which included the use of a mobile application, electronic monitoring wristbands, and/or the use of smartphone or tablet features such as texting, video calls, and videotaping.
Standalone Treatment	The intervention is administered solely via the mobile device without being administered alongside or in conjunction with an in-person treatment.
Enhancement to Treatment	The intervention is administered in-person and the mobile device is utilized as a supplemental feature of treatment.
Mobile Device Used	The type of mobile device utilized to deliver the intervention.
Mental Health Condition	The adverse behavioral or emotional symptoms exhibited by the children of the population of parents studied.
Intervention Used, Incorporated, or Adapted	The parent-targeted intervention utilized in the research study that can be fully used, shortened or selected from, or altered with primary skills being implemented.
Theory of Intervention Used	The theoretical foundation of the parent-targeted intervention.
Theory of Behavior Change Used in Design	A method of understanding how differentiations in treatments or interventions can cause changes in one's behavior (Hekler, Michie, Pavel, Rivera, Collins, Jimison, et al., 2016).
Behavior Change Techniques	Twenty-six methods utilized in the design of the mobile intervention in order to change an individual's behavior (Abraham & Michie, 2008). Specific definitions of these twenty-six techniques can be found in Abraham & Michie's taxonomy.
Youth Outcomes	Changes in youth symptoms or behaviors after parent-targeted intervention is administered.

Parent Outcomes	Changes in parent behaviors after parent-targeted intervention is administered.
Visual Design	Assessment of the visual quality and/or look and feel of the program, including aesthetics, layout, and size (Baumel et al., 2017).
Content	Assessment of the material provided and learned in the program, including evidence-based content, quality of information provision, completeness and concision, and clarity about the program's purpose (Baumel et al., 2017).
Features	Assessment of different aspects utilized in the design of the mobile intervention.

Identification of Behavior Change Techniques

Interventions were evaluated for type and number of behavior change techniques using Abraham and colleague's taxonomy of behavior change techniques [47].

Assessment of Visual Design and Content

Visual design and content were evaluated using Enlight, a 5-point rating system ranging from *1* very poor to *5* very good, developed for assessment of eHealth interventions [45].

Identification and Assessment of Theoretical Foundations

Theoretical foundations of the treatments and the mobile application were assessed through implementation of a theory coding scheme [48]. This coding scheme provides various steps in classifying the presence of usage of theory in interventions [48]. In the present review, theoretical foundations were coded as present based on their mention in either the article itself or in the references of the article (i.e., Item 1 [48]). When referenced or mentioned by the study, the presence of a theoretical foundation was coded. When assessing behavior change theory in the design of mobile interventions, it was noted if a theory was not specifically mentioned but alluded to in the study. Specifically, when a study mentioned the use of theory without providing the specific theory name or characteristics of the theory, this study was marked accordingly.

Results

Demographics and Designs of Reviewed Studies

Eleven studies were included in this review, and each study was assessed for demographic information (Table 2). The earliest study reviewed was published in 2014. Seven were randomized controlled trials. The sample sizes ranged from 10 to 371 participants. Most of the parents were mothers (ranging from 77% - 100%), apart from one study which focused on intervention delivery to fathers [49]. The parental ages ranged from 18 to 50+. The target child's ages ranged from 2 to 18 years of age. Each study recruited participants from a range of settings, including primary care clinics (n = 1), community health agencies (n= 4), social services (n = 2), juvenile justice centers (n = 1), early education agencies (n= 1), community

parenting support groups (n = 2), autism organizations and intervention centers (n = 1), child psychiatrist (n = 1), schools (n = 1), and social media platforms (n = 3). Families were included if the child had "externalizing behavior problems," "disruptive behaviors," "symptoms of conduct disorder," "autism spectrum disorder," and "attention deficit/hyperactivity disorder."

Among the studies, four did not report race or ethnicity of the sample, and the remaining samples were homogenous. Among studies that reported race or ethnicity, the majority (ranging from 79 - 95%) of participants were either minority families (*n* = 3 [50,51,52] or Caucasian (*n* = 4 [53,54,55,56]). Information pertaining to socioeconomic status followed a similar pattern. Five studies included families who were identified as coming from a lower socioeconomic background [50,51,52,54,55]; two studies included participants experiencing financial stress [49,53]; and the remaining four studies either did not report income [57,58,59], or any other socioeconomic information [56].

Of the studies that reported marital/partnership status of the parents (n = 8), caregivers, or legal guardians, five reported that the majority (ranging from 50% - 90.6%) of participants came from a two-parent household through marriage or cohabitation.

Treatments were implemented for time periods ranging from 2 to about 16 weeks. Four mobile phone-based interventions served as an enhancement to treatment, and seven served as standalone treatments. Most studies (n = 7) utilized a mobile application as a medium of delivery.

Table 2. Demographics of reviewed studies.

	Caregiver Identification[b] (%)	Child Gender (%)	Parent Age (%)	Child Age	Recruitment Settings	Parental Race and/or Ethnicity (%)	Socioeconomic Status (%)	Caregiver Composition (%)	Treatment Length
Breitenstein et al., 2016	Mother (94.9%)	Female (57%)	30-39 years (63.3%)	2-5 years	Primary care clinic	African American (64.6%)	> $20,000 per year (65.8%)	Not married (60.8%)	12 weeks
Feil et al., 2018	Female (77%)	NR	M = 44.7 years	8-12 years	Community parenting groups Social media	Caucasian (89%)	> $25,000 per year (29%) $25,000 - $50,000 per year (32%)	Two-adult household (63%)	4 weeks
Hemdi & Daley, 2016	Mother (100%)	NR	M = 32.9 years	M = 63.18 months	Autism organizations and intervention centers	NR	NR	Married (90.62%)	4 sessions
Jones et al., 2014	Female (71%)	Male (57%)	M = 35 years	M = 5.57 years	Schools Community health agencies	Ethnic minority (57%)	Low-income (100%)[c]	Single (57%)	8-12 sessions
Lefever et al., 2017	Mother (100%)	Male (56%)	M = 28.91 years	M = 4.56 years	Social service agencies Early education Community health agencies	Hispanic (46%) African American (33%)	M = $18,608 USD	NR	8 sessions
Mason et al., 2021	Female (90.4%)	Female (67%)	M = 45.6 years	M = 15.2 years	Community health agencies	White (84.6%)	NR[d]	NR	4 weeks
May et al.,	Father (100%)	NR	M = 42	4-11	Community	NR	Financial	Two-parent	16 weeks

2021			years	years (78%)	parenting groups Social media		difficulty (39%)	household (71%)	
Pina et al., 2014	Mother (80%)	NR	M = 38.4 years	NR[e]	NR	NR	NR	Two-adult household (100%)	2 weeks
Schaeffer et al., 2022	Female (100%)	Male (55.9%)	M = 39.4 years	M = 14.6 years	Social media Juvenile justice centers	White (76.5%) Hispanic/Latinx (14.7%)	$10,001–20,000 (17.6%) $20,001–30,000 (14.7%) $50,001–60,000 (14.7%) $60,000 and above (26.5%)	Sole adult household (44.1%) Two-parent household (29.4%)	12 weeks
Sonne et al., 2016	NR	Male (69.2%)	NR	M = 9.3 years	Community health agencies Child psychiatrist	NR	NR	NR	4 weeks
Sullivan et al., 2019	Mother (95%)	Male (55%)	M = 50 years	M = 8.9 years	Social service agencies	Caucasian (95%)	NR	Married (50%) Single (25%)	10 weeks

[a] NR = not reported

[b] Caregiver identification aligns with report in respective articles and identification as a mother or father should not assume gender.

[c] Jones and colleagues (2014) define low income as the "adjusted gross income did not exceed 150% of the federal poverty limit, which takes into account both income and number of residents in the home."

[d] Mason and colleagues (2021) did not provide specific financial ranges; however, the sample was described as low-income.

[e] Pina and colleagues (2014) does not provide ages and specifies that children in sample are in grades K-12.

Theoretical Frameworks

Transferring treatment to a digital platform requires consideration of the intervention's theoretical framework and theoretical frameworks that promote behavior change in a mobile platform.

Theoretical Framework of the Interventions

All of studies identified for this review drew from empirically based or evidence-based parent management training curricula, including the Chicago Parent Program, Behavioral Parent Training, Multisystemic Therapy, Behavioral Model Training, Helping the Noncompliant Child, Parent Behavior Training, and The Incredible Years Program. It is understood that the most prominent theoretical frameworks for these treatments include behaviorism (operant principles), Bronfenbrenner's social ecological framework, social learning theory, and the coercion model.

Six of the studies explicitly discussed social learning theory [50, 51, 52, 54, 56, 59], two discussed the coercion model [50,52], one discussed Bronfenbrenner's social ecological framework [55], and one discussed the transactional model of stress [57] as the main theoretical framework for the parenting interventions included in the apps. Four studies did not expressly mention the coercion model as a theoretical framework, but this model was implied through information related to app content [54,55,58,59]. For example, these studies described implementing skills such as parental communication, effective parent-child interaction, monitoring, and limit setting to improve parental responses to problematic child

behaviors, which is a tenet central to the coercion model [60]. Two studies did not expressly mention the guiding theoretical framework, nor did it provide enough information to make inferences about the theoretical framework [49, 53]. However, these studies did reference several behavioral parent training skills that are drawn from multiple interventions (e.g., parent child-interaction therapy, parent management training).

Across all the studies, when provided, there was general mention of the theoretical framework for the interventions. While most studies name the parenting skills used, few provide comprehensive and specific information about specific parenting strategies (e.g., examples of language used or description of the applications of skills to in vivo situations), apart from four studies [52,54,55,58]. These studies discuss examples of the applications of individual parenting skills to potential examples in daily life [52,55] or specific language used to deliver the skill [54,58].

Theoretical Frameworks Promoting Behavior Change in a Mobile Platform

Only two studies described use of behavior change theories in the design of the mobile intervention for parents [50,52], which included social cognitive theory [50] and self-determination theory [52]. Details about these frameworks were found by reviewing preliminary, formative research [31,50,52]. No other study provided information about behavior change theories as guiding the mobile intervention design. Of note, one study reviewed has a manuscript in preparation that aims to describe the development of the mobile app [55]. As such, this manuscript under preparation may allude to the behavior change theories that underlie the mobile app development. Nonetheless, the lack of behavior change theory implementation in mobile interventions is consistent with findings in past reviews [33,34,61], suggesting that designing mobile phone-based interventions without a theoretical foundation of behavior change within design is a common trend across different niches in the mobile intervention literature.

However, an evaluation of the studies using the taxonomy of behavior change techniques [47] revealed behavior change techniques were frequently used. The number of behavior change techniques included in the interventions ranged from two [44] to nine [52] techniques. The most used behavior change techniques within the apps included providing instruction (n = 9), prompting practice (n = 9), and prompting self-monitoring of a behavior (n = 8). Taken together, studies appear to implement some behavior change techniques widely, but the techniques were not guided by a stated behavior change theory in most of the studies (n = 9). See Table 3.

Table 3. Characteristics and features of reviewed studies.

	Sample / Design	Medium of Delivery	Standalone or Enhanced	Mobile Device Used	Mental Health Condition	Intervention Used, Incorporated, or Adapted	Theory of Intervention Used	Theory of Behavior Change Used in Design	Behavior Change Techniques	Parenting Techniques Used in Intervention	Youth Outcomes	Parent Outcomes
Breitenstein et al., 2016	N = 79 / RCT	MA	Standalone	T	Behavioral Problems	Chicago Parent Program	CT, SLT, SCT	SCT[a]	CR, GE, M/D, OSC, PF, PI, PP, SM	Parent-child relationship Clear expectations and rules Rewards and incentives Setting behavior goals Effective requests	NSC in child behavior problems	Improvement in parental warmth (d = 0.31) Improvement in parental self-efficacy (d = 0.13) Improvement in parental follow through on skills (d = 0.18)

Feil et al., 2018	N = 42 / RCT	MA	Standalone	SP	Conduct and Antisocial Behaviors	Behavioral Parent Training Skills	N/A	N/A	FU, GE, PP, RG, SGS, SM	Clear expectations and rules Rewards and incentives Setting behavior goals	N/A	NSC in parenting behaviors
Hemdi & Daley, 2016	N = 62 / RCT	MA[b]	Enhanced	SP	Autism Spectrum Disorder	Psychoeducation Intervention	DABCX, TMS	N/A	PIC, PIN, SM	Parent-child relationship	Improvement in hyperactivity (*d* = -1.58)	Reduction in parenting stress (*d* = -0.98) Reduction in parental depression (*d* = -2.05)
Jones et al., 2014	N = 15 / RCT	SPE	Enhanced	SP	Disruptive Behavior Disorders	Helping the Noncompliant Child	SLT, CT	SDT[a]	BI, CR, GE, M/D, OSC, PF, PI, PIN, PP, SM	Parent-child relationship Clear expectations and rules Rewards and incentives Effective requests Praise Planned ignoring Modeling	Improvements in intensity of disruptive behaviors (*d* = 0.99) Improvement in presence of disruptive behaviors (*d* = 0.54)	Improvement in parental engagement and generalization of parenting skills (*d* = 0.88) Increased participation in mid-week check-ins (*d* = 2.59) Increased completion of home practice (*d* = 0.63)
Lefever et al., 2017	N = 371 / RCT	SMS	Enhanced	MP	Behavioral Problems	Parent Child Interaction Module of SafeCare	SLT, EST	N/A	GE, PF, PI, PP	Parent-child relationship Clear expectations and rules Rewards and incentives Praise Modeling	Improvement in cooperative behavior (*d* = 0.38)	Increase in observation of parenting skills use (*d* = 0.68) Improvement in responsive parenting skills (*d* = 0.35) Growth of use of parenting skills (*d* = 0.28)
Mason et al., 2021	N = 52 / RCT	SMS	Standalone	MP	Substance Use	Behavioral Parent Training Skills	SLT, SCT, CT	N/A	IF, PIC, RG, PI	Parent-child relationship Effective requests Monitoring	Decrease in depressive symptoms (*d* = −.63) Decrease in anxiety symptoms (*d* = −.57)	Improvement in parent relations (*d* = 0.41) Improvement in parenting skills (*d* = 0.51)
May et al., 2021	N = 184 / PS	SMS	Standalone	MP	Autism Spectrum Disorder	Behavioral Parent Training Skills[c]	N/A	N/A	PIN, GE	Parent-child relationship	N/A	Improvement in parent-child relationship
Pina et al., 2014	N = 10 / PS	MA; EDA	Standalone	MP, T	Attention Deficit/ Hyperactivity Disorder	Parental Behavioral Therapy[c]	SLT, TTC	N/A	GE, IF, IRM, PI, PP, SM	Parent-child relationship Clear expectations and rules Setting behavior goals Effective requests Praise Planned ignoring Modeling	N/A	N/A
Schaeffer et al., 2022	N = 72 / RCT	MA	Standalone	SP	Conduct Problems	Multisystemic Therapy	EST	N/A[d]	PP, SM, IF, M/D, PI, PIN, RG, SGS, CR	Parent-child relationship Clear expectations and rules Rewards and incentives Setting behavior goals Effective	Decrease in substance use, delinquency, and status offenses (*d* = 0.54 to *d* = 0.84)	Improvement in discipline consistency (*d* = 0.44) Improvement in rule clarity (*d* = 0.32)

										requests Monitoring Modeling		
Sonne et al., 2016	N = 11 / PS	MA	Standalone	SP	Attention Deficit/ Hyperactivity Disorder	Incredible Years Program[c]	SLT	N/A[d]	IF, PI, PP, SGS, SM	Parent-child relationship Clear expectations and rules Rewards and incentives Setting behavior goals Monitoring	Reduction in inattention (*d* = 0.73) Improvement in conduct-related behaviors (*d* = 1.02) Improvement in youth sleep (*d* = 0.67)	Improvement in parental frustration
Sullivan et al., 2019	N = 45 / PS	MA	Enhanced	SP	Trauma	RPC, TIPS	AT, CBT, CDT, SLT, RT	N/A[d]	CR; M/D; OSC; PI, PIN, PP, SM	Parent-child relationship Clear expectations and rules Praise Planned ignoring	Increase in youth prosocial behavior (*d* = 0.40)	Improvement in parental self-efficacy (*d* = 0.41)

Note. AT = attachment theory, ASD = autism spectrum disorder, BI = barrier identification, CBT = cognitive-behavioral theory, CDT = child development theory, CR = providing contingent rewards, CT = coercion theory, DABCX = Double ABCX Model of Stress, DM = digital messaging, EDA = electro-dermal activity wristband, EST = ecological systems theory, FU = providing follow-up prompts, GE = providing general encouragement, HFT = habit formation theory, IF = prompting intention formation, IRM = prompt identification as a role model, MA = mobile application, MBSD = multiple baseline single-case design, M/D = model/demonstrate behavior by a professional, MP = mobile phone, N/A = not applicable because not reported or able to draw from study information, NSC = no significant change, OSC = opportunities to view social change, PF = providing feedback, PI = provide instruction, PIC = providing information on consequences of behaviors, PIN = provide information, PP = prompting practice, PS = pilot study, PSF = prompt self-talk, T = tablet, RCT = randomized controlled trial, RG = prompting the review of current goals, RPC = National Child Traumatic Stress Network's Resource Parent Curriculum, RT = resilience theory, SCT = social cognitive theory, SDT = self-determination theory, SGS = specific goal setting, SIL = social interaction learning, SIM = social interactional model; SLT = social learning theory; SM = self-monitoring of specific behavior; SMS = text messaging; SMT = providing stress management techniques, SP = smartphone, SPE = smartphone enhancements including text messaging, video calls, alarms, and skills videos, TE = technology enhanced, TIPS = Trauma Informed Parenting Skills, TMS = Transactional Model of Stress, TTC = transtheoretical change theory, WLC = wait-list control

[a] Theory was specified in a referenced article or preliminary work that was referenced

[b] Application used was not developed, but rather used from a pre-existing messenger application

[c] Intervention design was based on user and professional feedback, but drew on elements of mentioned intervention

[d] Application did not explicitly state theory but suggested the presence of a theory without providing content that the theory was used in this study

Design Elements

Features

Five features emerged as most common across digital interventions. First, many studies (n = 7) included an option for the end user to tailor mobile app intervention content or features. Options to tailor intervention content included: defining individualized behavioral goals such as completing household chores, following a bedtime routine, returning home by curfew, and completing homework (n = 4 [50,53,55,59]), creating a schedule for when to use the parenting skills provided in the app (e.g., choosing when to engage in particular modules, creating a routine for parents, and allowing ongoing access to psychoeducation) (n = 3 [50,56,59]) delivering just-in-time interventions according to individual stress (n = 2[55,58]), selecting rewards/contingencies they think their child would value (n = 4 [50,53,55,59]), and receiving psychoeducation tailored to individual circumstances (e.g., how to intervene when the child is in a risky situation and using time-outs with children who have experienced trauma) (n = 4 [50,52,55,56]).

Options to tailor app features included: choosing icons, avatars, and profile photos that

embody the user (n = 2 [53,62]); filming oneself practicing skills with the youth (n = 1 [52]); and integration of the user's name in the medium of delivery (n = 4 [53,55,59,63]). Notably, few studies provided visual examples or description of the treatment content and/or mobile platform. As a result, other design features may be embedded in the apps but not be identified in the present review.

Second, most of the mobile interventions (n = 8) included push notifications and/or text messages to prompt practice of strategies or provide reinforcement and/or encouragement [49,51,52,54,55,57,58,59]. Third, some studies (n = 3) included a mechanism for tracking child behaviors [53,55,59] such as completing steps in a routine, monitoring the youth's location, and assessing completion of positive behaviors. Behaviors were either tracked by parents [56] or by both parents and children [53,55,59], and logged by adding events to a log sheet [53,55] or by moving through a checklist in situ [59]. Behavioral tracking (i.e., assessing and following the behaviors of youth) was implemented through the mobile intervention for each of these studies. Fourth, some studies (n=4) included videos modeling parent-child interactions and other parenting skills [50,52,55,56]. Finally, half of the studies (n=5) generated a reward system for either the parent or the child [50,53,55,56,59] that was implemented through the mobile intervention. Those with reward systems for the child used points [53,55] and stickers [59]. Those with reward systems for parents offered completion badges and certificates [50] or accessories for an avatar family [56].

Content

Broadly, the mobile intervention content related to behavioral parent training skills included strengthening the parent-child relationship (n=10; all except [53]), setting clear expectations and rules (n = 8; all except [49,54,57]), establishment of rewards and incentives (n=6 [50,51,52,53,55,59]), setting behavioral goals for the youth (n=5[50,53,55,58,59]), use of effective communication and requests (n=5 [50,52,54,55,58]), praising desired behaviors (n=4 [51,52, 58, 62]), modeling effective behaviors (n = 4 [51,52,55,58]), planned/active ignoring (n = 4 [51,52,56,58]), and implementation of monitoring and supervision (n = 3 [54,55,59]). Although indication of behavioral parent training skills can be gleaned from the description of the intervention, it is challenging to determine the specific number of parent training skills. This challenge stems from a lack of information provided in articles that specify the areas of skills provided in mobile intervention. Of note, some studies [51,52] involve enhancements to an in-person treatment delivery, suggesting that additional skills are likely provided and discussed through the technology though not specified in the manuscripts.

Ideally, a review of app content includes an assessment across four domains: evidence-based content, quality of information provision, completeness and concision, and clarity about the program's purpose [45]. To fully implement this evaluation, studies must provide comprehensive information, including examples of content across the intervention (e.g., specific messages designed for the end user, video dialogue, prompts used to encourage practice, to name a few). Unfortunately, most studies included in this review did not include enough information for a thorough review of app content along these four dimensions. In fact, only one study allowed for partial evaluation of content according to the Enlight domains.

For eight of the studies, specific, direct content was not described [49,50,51,52,53,55,56,57]. Consequently, the content could not be evaluated against the Enlight domains.

Three studies provided specific examples of content [54,58,59]. However, the information was

not comprehensive in that it consisted of brief sample treatment statements and lacked psychoeducation related to the skills being implemented. For two of the studies [54,59], none of the Enlight domains could be evaluated. For the third study [58], some Enlight domains were assessed (i.e., clear and concise goals, quality information necessary to obtain that goal, and clarity regarding the purpose and target population of the program). The evaluation showed the content fulfilled these domains at *good* levels.

Visual Design

Ideally, a review of visual design includes evaluation of aesthetics, layout, and size [45]. Similar to content evaluation, studies must provide a comprehensive collection of visualization of the mobile app as this assessment examines consistency of font, harmony of colors used throughout, and size of the layout on the mobile device [45]. Most studies included in this review provided few visualization examples, which created difficulty in conducting a full assessment of the visual design used throughout the app.

Four studies were not evaluated for visual design because the interventions were either text-message based [49,51,54] or no visual information was provided in the article [57].

Among the remaining studies (n = 7), six included examples of the mobile intervention with snapshots of select screens, rather than a visual design sample of the application in its entirety [50,53,55,56,58,59]. Of note, one of these studies included visualization of their mobile app through a website, rather than the study itself [55]. Because of the scarcity of visual examples among the studies included in this review, evaluation based on Enlight was completed for the components of the intervention the researchers selected to present, rather than the application in totality. Results showed the aesthetics classifications included not attractive (n =1), fair (n = 1), attractive (n = 2), and very attractive (n =2). The layout classifications ranged from fair (n = 1), to good (n = 4), and very good (n = 1). The size qualities ranged from fair (n = 1), to good (n = 2), to very good (n = 3).

Most studies implemented muted colors on certain screens or activities for parent-directed content [50,56,58,59]. For parent and child-directed or child only-directed content, colors were brighter than those seen on parent-directed screens [53,59]. Using brighter colors with children aligns with the robust literature that younger children prefer brighter, more saturated colors over more muted colors [64,65,66]. The use of families was an overwhelmingly common visual design element. For example, studies either had photos on homepages of families akin to those using the application [50], photos of the families themselves [53], or integration of the names of the children [55].

Treatment Outcomes

Youth Outcomes

Eight studies provided youth outcomes. Among these studies, a majority (n = 7) indicated that youth significantly improved. Six of the studies were randomized controlled trials and indicated that youths showed greater improvement in the technology-enhanced group when compared to the control group [50,51,52,54,55,57]. Overall, youths in these randomized trials exhibited a decrease in behavioral and mood-related problems [51,52,55,57]. For example, with small to medium effect sizes, Lefever and colleagues [51] report that youth with parents in the intervention condition demonstrated a significant improvement in cooperative behavior with a small to medium effect size (d = 0.38); Hemdi & Daley [57] report significant

improvement in hyperactivity for youth in the intervention condition with a large effect size (*d* = -1.54); Jones and colleagues [52] report significant improvements in intensity (*d* = 0.99) and presence of disruptive behaviors (*d* = 0.54) with medium to large effect sizes for youth in the intervention condition; Mason and colleagues [54] reported a significant small-to-medium effect sizes demonstrating a decrease in depressive (*d* = −.63) and anxiety symptoms (*d* = −.57); and, Schaeffer and colleagues [55] report significant decreases in substance use, delinquency, and status offenses for youth in the intervention condition with medium to large effect sizes (*d* = 0.54 to *d* = 0.84).

The remaining two studies were pilot studies [56,59]. While not compared to a randomized treatment group, these two studies reported similar improvements in youth behavioral problems. For example, Sonne and colleagues [59] report a significant reduction in inattention at a medium effect size (*d* = 0.73), improvement in conduct-related behaviors (*d* = 1.02) at a large effect size, and improvement in youth sleep (*d* = 0.67) at a medium effect size. Sullivan and colleagues [56] report an increase in youth prosocial behavior at a small effect size (*d* = 0.40).*Parent Outcomes*

Most studies reported parental outcomes (n = 10). Many studies reported parental improvements when using mobile technology. Among the studies using a randomized control trial design (n = 7), nearly all reported parental improvements in the technology intervention group when compared to their respective control groups. Specifically, Breitenstein and colleagues [50] report improvement with small to medium effect sizes in parental warmth (*d* = 0.31), parental self-efficacy (*d* = 0.13), and parental follow through on skills (*d* = 0.18). Hemdi & Daley [57] report large effect sizes for reduction in parenting stress (*d* = -0.98) and parental depression (*d* = -2.05) among parents in the mobile intervention group. Lefever and colleagues [51] report a medium effect size in the observation of parenting skills use (*d* = 0.68), a small-to-medium effect size in the improvement in responsive parenting skills (*d* = 0.35), and a small effect size in the growth of use of parenting skills (*d* = 0.28). Jones and colleagues [52] report a greater improvement in parental engagement and generalization of parenting skills for the parents using a mobile intervention with weekly attendance (*d* = 0.88), participating in mid-week check-ins (*d* = 2.59), and completion of home practice (*d* = 0.63) reflecting medium to large effect sizes. Feil and colleagues [53] report a small-to-medium effect size in the reduction of negative parenting behaviors, though the researchers note that this finding is insignificant and do not report that coefficient. Schaeffer and colleagues [55] report small to medium effects in the improvement of discipline consistency (*d* = 0.44) and rule clarity/structure (*d* = 0.32). Mason and colleagues [54] report small to medium effect sizes in the improvements of parent relations (*d* = 0.41) and parenting skills (*d* = 0.51) reflecting medium effect sizes.

The remaining three studies were pilot studies that incorporated parental outcomes. Although these studies did not use a randomized group as a comparison, they described a small effect in the improvement of parental self-efficacy (*d* = 0.41 [56]), significant improvements in parental frustration [56], and improvements in parent-child relationship [49] among the participants engaging in mobile intervention.

Discussion

This study systematically reviewed non-commercial mHealth apps that provide behavioral parent training or components of behavioral parent training for parents of children with behavior problems. The present study had the specific goals of summarizing (1) general

characteristics, (2) theoretical frameworks and empirical evidence, and (3) parenting strategies. The broad aim for this review was to use the results to inform the development of an app for parents of teens who are involved in substance use behaviors.

Use of Theory

The present review found all studies included in this review used parent training interventions that are theoretically grounded. However, there was a paucity of clear information outlining the theoretical framework for the components designed within the mobile apps. While many of the apps were based on face-to-face parent management training interventions that have well-established theoretical frameworks (e.g., Helping the Noncompliant Child, Parent-Child Interaction Therapy, Parenting Management Training), studies often only referenced the interventions [51,54,56,59] or reported specific parenting skills without specifying the originating intervention [49,53,57]. Determining relevant theoretical frameworks required deductive reasoning based on knowledge of the named intervention or parenting skill. Using this expertise, we found that many of the apps (n=6) used social learning theory [67] while only a few [50,52,58,59] indicated the coercion model [60], either by mentioning this model by name [50,52] or by describing the benefits of the parenting skills that were selected for inclusion in the apps [58,59].

Given that parent training interventions can draw from different theoretical frameworks beyond social learning theory and the coercion model [68] and that the full in-person treatment programs were not transferred to mobile apps in the studies reviewed, implicit communication of the theoretical framework through naming the originating intervention or specific skills only is not sufficient. It is important to clearly state the relevant theoretical framework for the content transferred to mobile devices, as the inclusion of a particular intervention does not guarantee that its principles are embodied in the mobile platform. A deeper analysis of whether specific interventions are consistent with the theory in terms of mobile app features is limited due to a lack of information.

Behavior Change

Though behavior change theory is a vital component of mobile interventions [33,34,60,70], results of the current review found that most of the studies did not explicitly refer to behavioral change theory. The absence of behavior change theory as a framework for app design in many of the studies reviewed may be due to at least three reasons. First, many studies failed to provide sufficient information about the content and development of mobile intervention, making it challenging to understand the detailed study characteristics. Second, studies may be relying on behavior change theories for the originating curriculum due to the well-established programs on which the interventions are based. However, this overlooks the challenges of transferring interventions to mobile devices. Many parent management curriculums incorporate behavior change theories that consider factors such as personal motivation, social support, and perceived barriers and/or benefits of behavior change. While similar theories may be used in mHealth interventions, there are additional considerations, such as the need to focus more on technology-specific behavior change theories. For example, the technology acceptance model [71] focuses on how individuals perceive and adopt novel technologies, and it may be a suitable theory to embed in mHealth development. While some studies have considered post-hoc acceptability, the lack of prior designs centered on the individual's perspective remains a gap. Third, there may have been a general neglect of

including a coherent behavior change theory in the intervention's design. Given the impact of behavior change theory on the effectiveness of interventions [33,34,69,70], its inclusion is crucial for the development of effective parent-targeted mobile interventions.

Although behavior change theories were not commonly cited in the studies reviewed, behavior change techniques were used. The most used techniques were providing instruction, prompting practice, and self-monitoring [47]. The findings of the current study are consistent with prior reviews showing self-monitoring was the most frequently used behavior change technique in mobile interventions across different populations [33,35]. In the present review, self-monitoring described tracking both the implementation of parental skills and/or behaviors and the presence of desired behaviors in children. The limitations of the studies in terms of behavior change theory and techniques will be discussed further while summarizing the design elements.

Mobile Intervention Design

The design of mobile interventions in this review was evaluated based on their content, visual design, and features. Most of the studies in the review did not provide clear information on the specific parenting skills they included in the app. When information was provided, there was limited detail on the selection and integration of the skills into the mobile platform. This lack of information made it challenging to critically assess these interventions and consider them in their entirety for use with different populations, such as parents of adolescents recovering from substance misuse.

The visual design and features of the mobile interventions in the review were designed to be personalized. The mobile interventions each had their own way of promoting personalization through visual design and features. For example, users could customize the visual design by selecting icons, fonts, and colors that are personally appealing [50,53,59]. This trend of personalizing the layout and design has also been noted in previous literature reviews [72], suggesting consistent focus across populations and areas of study. The features of these mobile interventions also facilitated individuality, including avatar families [56], tailored messages [51], and the option to choose specific skills to practice based on individual needs [50].

In addition, the use of badges, rewards, logs, and/or tokens as a feature in the mobile interventions reviewed was a common trend. This feature was also noted in previous reviews as prevalent [72]. The use of rewards aimed at positively reinforcing desired behaviors in both parents and adolescents and encouraged individualization. Positive reinforcement, in which a stimulus increases the frequency of a particular behavior, is a well-established behavior change technique [73]. When implemented within a structured framework, positive reinforcement can be effective in promoting desired behaviors [73].

Treatment Outcomes

The preliminary findings of the studies reviewed indicate potential for positive parent and child outcomes following use of a behavior parent training app [49,51,52,54,55,56,57,59], but further research is necessary to support these findings. Most studies that reported on youth and parent outcomes utilized interventions that were grounded in well-established theoretical frameworks [50,51,52,54,55,56,57,59], suggesting that theory-driven interventions may play a critical role in outcomes following behavioral parent training delivered through mobile devices.

To optimize the effectiveness of behavior parenting apps, future studies should incorporate behavior change theories in the design and development process. The limited information available in previous studies on the content and development of parent-targeted interventions within mobile platforms makes it challenging to identify the behavior change theory applied, if any (for exception see [31,50,55,74,75]). Thus, further empirical research is necessary to determine the influence of behavior change theory on the outcomes of behavior parent training delivered through mHealth apps.

Implications for mHealth Parenting Apps to Address Teen Substance Use

The development of behavioral parent training apps for parents of children with mental health difficulties is still in the preliminary stages, with available apps developed primarily for parents of younger children. However, there is a need for apps for parents of adolescents with conduct problems, including substance use. These apps are crucial as effective parenting strategies are related to decreased levels of substance use [2,3]. However, it is challenging for parents to both access and engage in evidence-based treatments with behavioral parenting strategies in community settings [76,77].

As a result, engagement in mobile platforms may be helpful for parents with difficulty accessing treatment in the community. However, while mHealth platforms provide accessibility, customization is key to fostering engagement. Thankfully, the current review of mobile health (mHealth) apps for delivering behavioral parent training revealed that most apps have features such as customization and personalization, which are considered good practice [78,79]. However, the reviewed apps lacked integration within the app and between the app and smartphone devices. This limitation is due to the predominant focus on parents of younger children. However, as parents spend less time with their children and key parenting strategies broaden to include monitoring and supervision during adolescence [80], the integration of features is likely to become increasingly important for behavioral parent training apps. To address this gap, it is recommended that a more comprehensive integration of app design and mobile phone features occur for apps targeting parents of adolescents.

For example, location-based reminders could be used to track a teen's location and send reminders or prompts relevant to their current location to the parent, as parents often either rely on youth reports of their location or do not check-in on potential location changes. Specifically, if the teen is at a location where they are likely to use substances, the app could send a reminder for the parent to have a pre-planned conversation with their adolescent or to check up on their teen's whereabouts. Geofencing could also be used to set up virtual boundaries around specific locations, sending an alert or reminder when the teen enters an "off limits" and suggestions for which parenting strategies to use to address the infraction. Alternatively, an alert with scripted language that is consistent with effective praise [21] could be sent to the parent if the teen's movements suggest an off-limits area was avoided so the parent can engage in providing praise in the moment as immediate praise and feedback is key for changing behavior[73]. Notably, Schaeffer and colleagues [55] use similar location-based strategies to encourage monitoring and supervision of adolescents.

Additionally, an app could be designed to use GPS data to generate reports that summarize the adolescent's whereabouts over time. These reports could serve as personalized feedback with recommendations to the parents. This sort of analysis could help parents discern patterns and areas that require use of certain parenting strategies. Moreover, push notifications could be

integrated to remind parents to use a specific parenting strategy at a designated time or in response to a trigger that was defined by the personalized feedback report. Rich integration of features may bring social learning theory and the coercion model to the forefront, resulting in the potential integration of behavior change theories and techniques. If so, this integration could address limitations in most current non-commercial apps.

Limitations and Strengths

It is important to consider the results of this review within the context of a few limitations. First, this review only looked at a specific area of mHealth research: mobile phone-based interventions that were designed to provide behavioral parenting practices to parents of children with mental health difficulties. Studies on mobile interventions to target parenting for parents of children with medical issues were not included in this review. Given overlap in issues related to ineffective parenting between parents of children with behavior problems and parents of children with chronic medical conditions such as asthma and obesity[81], future reviews may benefit reviewing parenting apps designed for parents with chronic medical conditions and conduct problems for a broader view. Second, the current review was based on a new field of research. As such, there was a paucity of studies available for review. As a result, studies included children of different ages, spanning different developmental windows and parenting needs. Notably, two studies provided insight into current behavioral parenting apps for solely teens [54,55]. Third, because of the small pool of studies, synthesis of data to obtain overall effect sizes was not possible. Therefore, as the field grows, effectiveness of parent-targeted mobile interventions for parents of youths with mental health issues should be empirically assessed using statistical analyses to develop a meta-analysis. The garnering of data will provide a more empirical result of the effectiveness of parent-targeted mobile phone-based intervention in a population of youths with mental health difficulties.

Despite these limitations, this review has some strengths that make it valuable for understanding current non-commercial parenting apps for informing development of similar apps for related problems in childhood and adolescence. First, by focusing on behavioral parenting apps for parents of children and adolescents with mental health difficulties, this review provides targeted and relevant information for developers who are interested in designing an app using parenting practices that are well established for other youth behavior problems, including substance use [2,3,4,7,82]). Second, results of this review provide clear information about current trends and patterns so future research can more closely align development of apps with design features that may increase treatment engagement [72,83] and, hopefully, buttress outcomes.

Conflicts of Interest

None declared.

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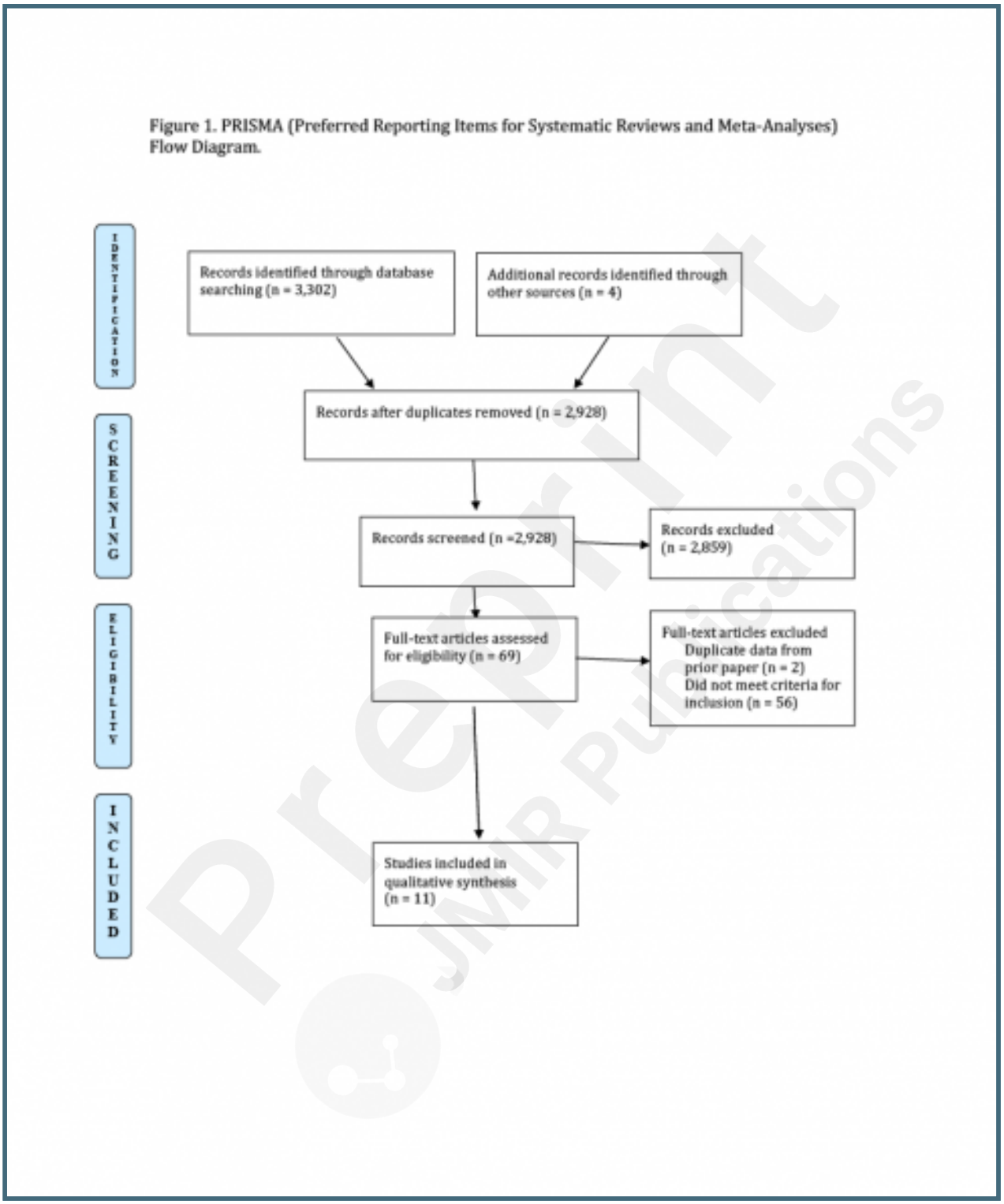
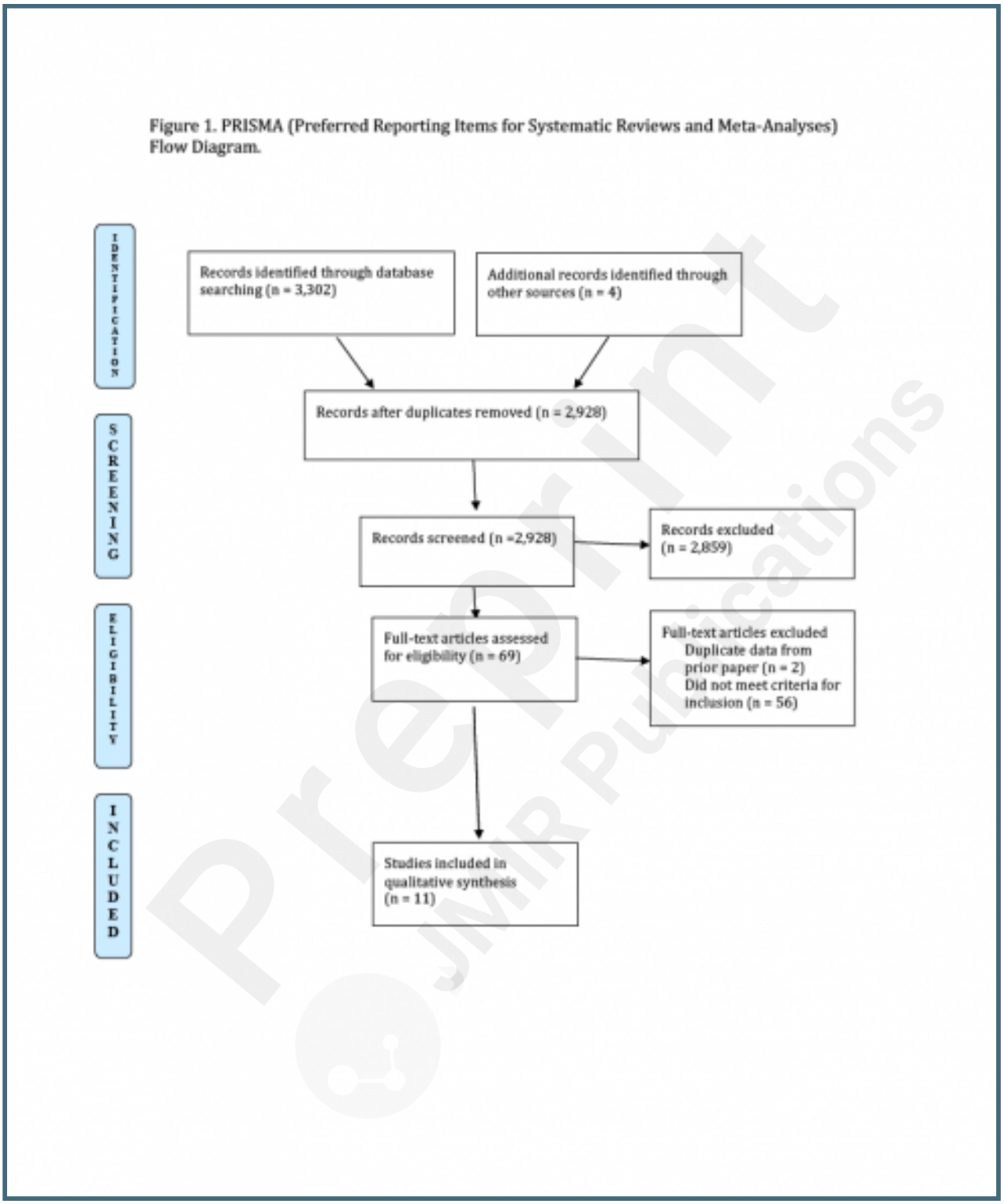
Supplementary Files

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Flow Diagram.



Figures

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Flow Diagram.



CONSORT (or other) checklists

PRISMA Abstract Checklist.
URL: http://asset.jmir.pub/assets/9f8436347763b17fa1f9a5e4ebb629c7.pdf

PRISMA Checklist.
URL: http://asset.jmir.pub/assets/4dca8265a39c9a7eebbc9a1d8cbbdbb5.pdf