REVIEW ARTICLE

WILEY

Systematic review: Digital recovery support services used to support substance use disorder recovery

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Abstract

Substance use, misuse, and disorders (SUDs) are estimated to cost the United States over $500 billion annually. While there are effective SUD behavioral interventions and treatments, there is mounting evidence that technology-based, digital recovery support services (D-RSS) have the potential to prevent SUD, complement formal treatment, and improve individual recovery-related outcomes. This preregistered systematic review focuses on D-RSS that provide SUD recovery support through websites, smartphone applications, recovery social network sites, or any combination thereof. Data sources included studies found in searching CINAHL Plus (EBSCO), EMBASE, MEDLINE (EBSCO), Index Medicus/MEDLINE (NLM), Psychology & Behavioral Sciences Collection (EBSCO), PsycINFO (ProQuest), ProQuest Psychology Journals (ProQuest), and retrieved references. Observational, mixed-methods, qualitative, or experimental studies, published in English, between January 1985 and January 2019, that characterized users and recovery-related outcomes of any D-RSS were included. The initial search yielded 5,278 abstracts. After removing duplicates, as well as reviewing titles and abstracts and removing studies not indicating an examination of recovery (i.e., treatment or prevention focused) and digital supports, 78 abstracts remained. Final included studies (n = 22) characterized international users of multiple D-RSS types, including websites, digital recovery forums, recovery social networking sites, smartphone applications, and short messaging service texting programs. Experimental evidence was lacking as most studies were observational or qualitative in nature (n = 18). The review suggests that the evidence base for most D-RSS is still lacking in terms of demonstrating benefit for recovery-related outcomes. Descriptively, D-RSS have high usage rates among engaged participants, across a range of SUD and recovery typologies and phenotypes, with 11% of U.S. adults who have resolved a SUD reporting lifetime engaging with at least one D-RSS. D-RSS deployment can help ameliorate barriers related to accessibility and availability of more traditional recovery supports, and may well be a valuable tool in addressing SUD and supporting recovery as uptake increases across the United States.

KEYWORDS
mHeath, mobile technology, social media

1 | INTRODUCTION

According to the 2017 National Survey on Drug Use and Health (NSDUH), an estimated 19.7 million individuals aged 12 or older had an alcohol or drug use disorder (i.e., substance use disorder [SUD], alcohol use disorder [AUD], opioid use disorder [OUD], etc.), yet few received specialty SUD treatment (2.5 million individuals), and less received nonspecialty treatment (i.e., attended mutual aid programs; 1.5 million individuals) (Substance Abuse and Mental Health Services Administration, 2018). Among individuals with a SUD who receive treatment, recurrence of substance use is common, with more than two-thirds returning to use within months of exiting treatment (McLellan, Lewis, O'Brien, & Kleber, 2000; Paliwal, Hyman, & Sinha, 2008). As very few affected people seek face to face treatment services, and SUDs are often susceptible to relapse following intervention, researchers and clinicians have looked to how technology-based digital recovery support services (D-RSS) can increase the reach of SUD interventions and lower the threshold for engagement, complement formal and nonformal treatment, and improve SUD recovery-related outcomes. At the same time, it is important to recognize many individuals (46.1%) resolve a substance use problem without engaging in formal SUD treatment or in any recovery support service (RSS) (Kelly, Bergman, Hoeppner, Vilsaint, & White, 2017). Similarly, the predominant pathway to recovery among those who do engage with treatment or RSS is not in fact formal treatment, but rather mutual aid recovery programs such as Alcoholics Anonymous (Kelly et al., 2017).

For the purposes of this review, we use the following definition of recovery: "an individualized, intentional, dynamic, and relational process involving sustained efforts to improve wellness" (Ashford et al., 2019). The factors positively related to sustained recovery include employment, housing, supportive social networks, improved coping skills, and activities that promote self-esteem and a sense of belonging (Bandura, 1977; Burling, Reilly, Moltzen, & Ziff, 1989; Dobkin, Civita, Paraherakis, & Gill, 2002; Havassy, Hall, & Wasserman, 1991; Jones & McMahon, 1996; Moos & Moos, 2007; Witkiewitz & Marlatt, 2004). RSS are an array of in person services, delivered via professional or peer channels, concerned with promoting the long-term outcomes of an individual's recovery process (Kaplan, 2008; Sheedy & Whitter, 2013; White, 2008, 2009). While formal treatment, or SUD interventions, are designed to initiate recovery and may also be designed to enhance recovery, RSS differ from formal treatment in that they are nonclinical services, often delivered by peers, available in the community, and are often delivered over longer periods of time (i.e., months and years versus weeks) (White, 2008, 2009). As a set of services and resources, RSS often fall into the domains of education, employment, housing, social/peer support, and continuing care, intended to improve the functioning and wellness of individuals (Ashford et al., 2019; Kaplan, 2008). D-RSS fit within the broader array of these more traditional in vivo (i.e., face to face) RSS, though they exist entirely within the digital domain.

D-RSS are RSS that are delivered via technological platforms such as smartphone applications (or "apps"), websites and forums, and social network sites and networking platforms (Bergman, Claire Greene, Hoeppner, & Kelly, 2018). D-RSS are a relatively novel development in the SUD and recovery field, though preliminary evidence suggests they may help to reduce individual barriers related to accessibility (through minimizing the need for transportation), availability (not requiring a support to be available in a specific geographic area), and cost (many are available for free on public platforms) (Bergman et al., 2018; Bliuc et al., 2017). Theoretically, D-RSS may operate in the same manner as in vivo RSS, intending to build recovery capital, instill hope, and mitigate behavioral stress (Kelly & Hoeppner, 2015)—though the exact mechanisms and effects of D-RSS are unknown.

Given that most adults have access to a wide range of digital technologies like computers, cellphones, tablets, and smartphones and are accustomed to accessing them for entertainment, health information, and social interactions (Pew Research Center, 2017), D-RSS are a promising platform to address the need of providing recovery support for SUDs. In fact, when people in SUD treatment were asked about their interest in the use of digital platforms to monitor personal recovery, the majority of respondents said they would most prefer an app on their phone or to receive text messages (Ashford, Lynch, & Curtis, 2018). Given a rapidly moving field and associated RSS literature, a systematic review regarding what is known and what needs to be known may be helpful in aiding appraisal of the state of the science regarding the clinical and public health utility of D-RSS and future directions.

1.1 | Research objectives

This systematic review seeks to establish what is known of the mechanisms, characteristics, utility, and feasibility of D-RSS for individuals with current or remitted SUD. As such, the objectives are: (a) to describe the characteristics of existing D-RSS, (b) to summarize the mechanisms or aspects of D-RSS that individuals perceive as beneficial and engage with most frequently, and (c) if possible, to outline the efficacy of D-RSS to support recovery-related outcomes such as abstinence or intrapersonal trait (e.g., self-esteem, self-efficacy, etc.) improvements. Additionally, we will examine whether D-RSS and their user bases differ as a function of the platforms on which they are delivered (e.g., do those users engaging with recovery websites differ from those using smartphone applications, etc.). We will also explore the presence of unique uses of technology in D-RSS, including adoption of publicly available platforms (i.e., Facebook), machine learning, and wearables (i.e., wearable sensors). The review protocol was prospectively registered via PROSPERO (#CRD42019119731); PROSPERO Registration: Robert Ashford, Brenda Curtis, Brandon Bergman, JohnKelly. The use of digital applications and platforms in the provision of substanceuse disorder recovery support: a systematic review. PROSPERO 2019CRD42019119731 Available from: http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42019119731.

2 | METHODS

2.1 | Data Sources

We conducted a search of seven academic, electronic databases, including: CINAHL Plus (EBSCO), EMBASE, MEDLINE (EBSCO), Index Medicus/MEDLINE (NLM), Psychology & Behavioral Sciences Collection (EBSCO), PsycINFO (ProQuest), and ProQuest Psychology Journals (ProQuest). Each database was searched for studies published from January 1, 1985 through January 5, 2019. These dates were selected to ensure we would capture the earliest studies to the most recent. The reference list of each article included in the final review was also examined for potential inclusion of relevant studies not found in the database search (i.e., cited reference searching). All authors reviewed a record of the studies included to guarantee all papers relevant to the study were obtained.

Search terms were developed based on a preliminary review of the literature and on information obtained from recovery science experts, individuals in recovery, and consulting academics. Due to the individual syntax codes and specificities of the electronic databases, the search terms were adapted according to each database search standards and best practices. As one example, the search strategy for CINAHL was as follows:

> (MH "Substance Use Disorder") OR "alcohol" OR "drug*" OR (MH "Substance Use") OR substance dependence" OR "addiction*" OR "substance misuse*" OR "alcohol abuse*" OR "drug abuse" AND "recovery*" OR "recover*" OR (MH "Recovery Support") OR "support*" OR (MH "Aftercare") OR "continuing care" AND "digit*" OR "technolo*" OR "social network*" OR "web*" OR (MH "Application") AND "recovery*" OR "support" OR "service*" OR "intervention*" OR "digital program*" OR "programme*" OR "care"

2.2 | Inclusion criteria

To be included in the review, study participants needed to have a SUD, either through formal diagnosis or self-identification of current or past problematic substance use by participants. Studies also needed to have provided access to, or asked preference and usage questions about, digital platforms and applications providing RSS. Studies that focused on providing SUD treatment or prevention, rather than recovery support (including aftercare), were not eligible. Included studies were published between 1985 and 2019 and published in English. Previously conducted systematic and nonsystematic literature reviews were not included, but references of these studies were reviewed to ensure coverage of all relevant studies in the current review. Studies that featured both in-person and digital supports, or only digital supports, were included. Two authors (R.D.A. and B.C.) applied these criteria to all identified abstracts; if inclusion criteria could not be satisfied or determined from the abstract, the full article was reviewed. Discordant eligibility determinations were resolved by consensus.

2.3 | Data extraction

Full-text manuscripts that were mutually approved for review inclusion were obtained. These texts were then assessed in greater detail, with use of a data extraction table. Extracted study characteristics included the authors, year of publication, location/setting of study, study title, study design, funding source, participant characteristics (sample size, gender, age, race), SUD type (SUD, AUD, OUD, etc.), remission/recovery status (recent discharge from treatment, early recovery/remission, or long-term recovery/remission), type of recovery modality (abstinence-based, harm reduction/moderation, pharmacotherapy, etc.), reported characteristics and features of the D-RSS, reported use of novel technology as an adjunct to the support service, and reported primary findings/results. Data extraction was carried out independently by three reviewers (R.D.A., B.C., and B.B.). For data that could not be extracted due to lack of information reported in the full texts, the corresponding author was contacted to provide missing details.

2.4 | Quality assessment

To strengthen the reporting of observational studies in epidemiology, we used the Strengthening the Reporting of Observational Studies in Epidemiology checklist (STROBE; Vandenbroucke, Poole, Schlesselman, & Egger, 2007) to assist in assessing quality of the included studies. Additionally, the authors created a list of review-specific questions to further assess quality (Table 1).

TABLE 1 Assessment questions used in review of study quality

Assessment question	Response options
Were participants diagnosed with drug or alcohol misuse/addiction in accordance with DSM, ICD or other reliable diagnostic criteria prior to treatment?	(Y/N)
Were participants diagnosed with drug or alcohol misuse/addiction remission, in accordance with DSM or other reliable diagnosis criteria?	(Y/N)
Was the delivery of recovery support services done explicitly via digital means?	(Y/N)
Was the overall health of participants clearly reported with regards to comorbid condition such as any psychiatric disorders, anxiety, depression, etc.?	(Y/N)
Were the recovery support services delivered in accordance with evidence-based standards outlined in the literature, or via organizations such as the Substance Abuse and Mental Health Services Administration?	(Y/N)
Was there a clear record of participants' recovery support engagement including reporting of individuals who dropped out or lost contact during treatment or at follow up?	(Y/N)

Abbreviations: DSM, diagnostic and statistical manual of mental disorders; ICD, international statistical classification of diseases and related health problems.

2.5 | Data synthesis

A meta-analysis was not appropriate for analyzing the extracted data of the included studies due to the novel, often qualitative or observational nature of the research designs. The absence of quantitative data on the effectiveness of D-RSS precluded a quantitative synthesis. As such, the review provides a narrative analysis of the included studies focused on their application to the primary research objectives.

3 | RESULTS

3.1 | Literature search

A total of 5,278 abstracts were located, in which 78 remained after removing duplicates and reviewing titles and abstracts. Of these, a total of 22 studies met inclusion criteria and pertained to the

provision of D-RSS or the prevalence of D-RSS usage among a population. An overview of the search results and screening criteria is summarized in Figure 1.

3.1.1 | Study characteristics

Given the breadth of this review, considerable variation was found in study aims and research questions, methodology, sample size, and outcome measures. Table 2 provides an overview of the heterogeneity of the data using the variables: author/date/country; study main findings; research design/methodology; and digital platform. A majority of the included studies (*n* = 18) used either observational (i.e., naturalistic research of individuals engaged with a D-RSS) or qualitative methodologies. The remaining studies (*n* = 4) were randomized control trials. Four studies described D-RSS use prevalence and preferences among individuals in the United States and the United Kingdom. Different
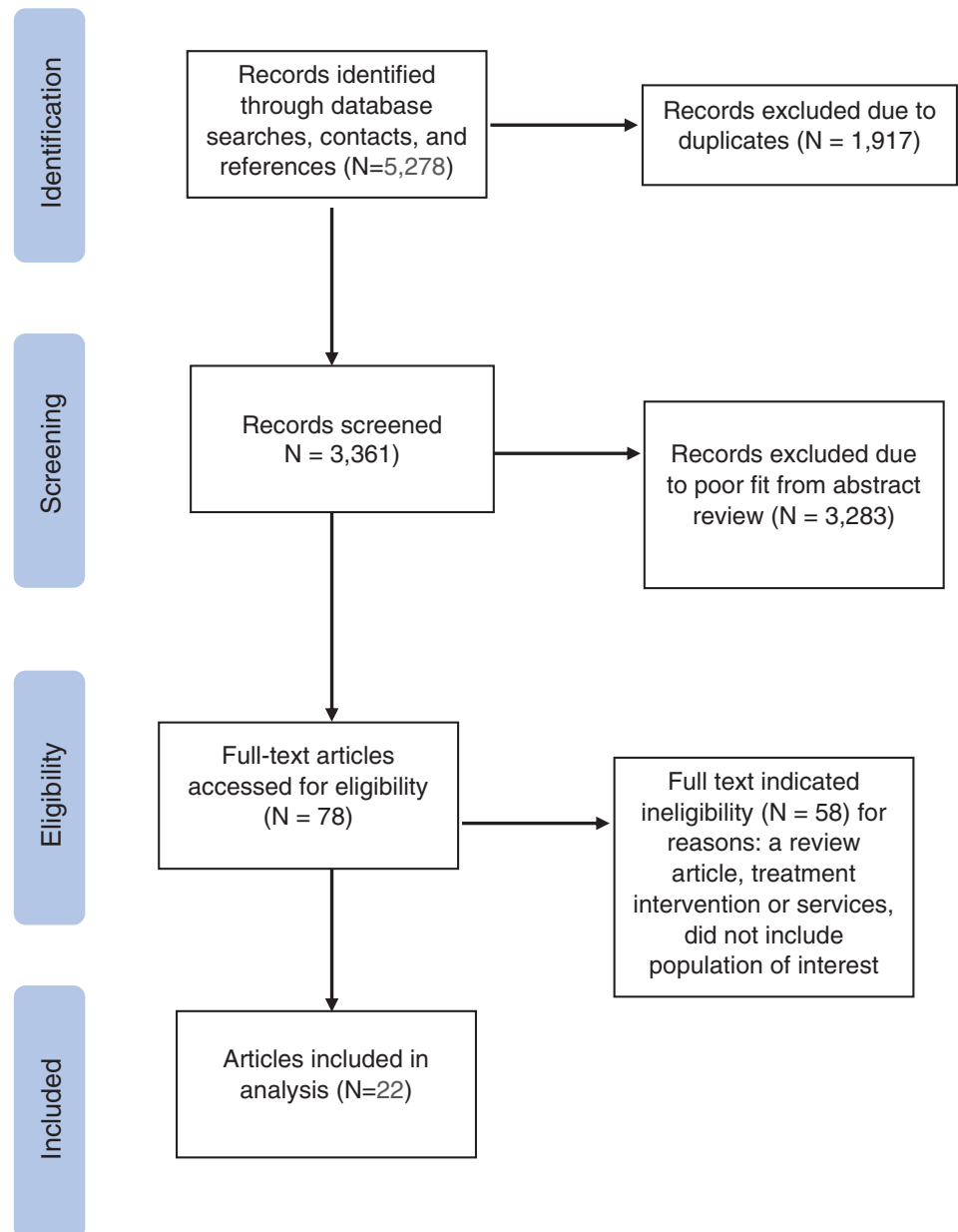

FIGURE 1 Flow diagram of study selection

TABLE 2 Manuscript characteristics

Author(s)	Location/setting	Design	Characteristics of the digital support	Primary findings/outcomes
Bergman et al. (2018)	Nationwide (United States)	Observational	N/A (prevalence of D-RSS study)	11% of individuals resolving a SUD in the United States (adults only) have engaged in some form of digital recovery support service; younger age, lifetime prescription for an AUD or OUD medication, in person nonmutual aid recovery support service use, and younger age of first substance use were associated with greater odds of digital recovery support service use.
Bergman, Kelly, Hoeppner, Vilsaint, and Kelly (2017)	InTheRooms.com	Observational	Recovery social networking site; website; smartphone application; live online video recovery meetings; recorded recovery speakers; forums; daily motivation messages; database of in-person recovery meetings	The average participant was "active" on ITR—the target recovery SNS in the study—for 30 min several times per week. The most common lifetime and past-90-day activities were reading a daily meditation prompt and attending a live online video meeting. Participants were likely to perceive benefit from ITR engagement. Individuals abstinent for 1 or more years (1+) reported similar ITR participation and perceived benefit (e.g., enhanced recovery self-efficacy) compared to those abstinent for less than 1 year or not abstinent (<1).
Best, Bliuc, Iqbal, Upton, and Hodgkins (2018)	Jobs, Friends, & Housing (JFH) online Facebook community, United Kingdom	Observational (with use of social network analysis; linguistics analysis)	Public Facebook page used to disseminate information and foster connection among participants	Group identity markers increased, but only for members that were present before the event occurred—finding pertains to using D-RSS to observe changes rather than fostering change.
Bjerke, Kummervold, Christiansen, and Hjortdahl (2008)	Norway; SMS messaging	Qualitative	SMS text messages between staff and participant (conversational DYAD)	SMS allowed participants who lived further away geographically to feel connected; participants felt the technology was easy to use; participants felt greater sense of connectedness.
Bliuc, Doan, and Best (2018)	SoberRecovery.com	Observational (with use of linguistics analysis)	Digital website forum	Linguistic analysis found that self-stigma was associated with negative emotion, as well as between self-efficacy and both positive and negative

TABLE 2   (Continued)

Author(s)	Location/setting	Design	Characteristics of the digital support	Primary findings/outcomes
				emotions. Group identity moderated this relationship. Participation in the online forum helped form group identity, moderating negative effects of stigma.
Campbell, Hester, Lenberg, and Delaney (2016)	Nationwide; web application and in-person SMART meetings	RCT	Digital website, module-based learning (based in SMART Recovery)	The digital support (Overcoming Addiction website modules) produced similar outcomes to the in-person SMART recovery meetings (reduced drinking, increase in days abstinent). Participants were not likely to use OA by itself (only 22 participants engaged in OA by itself), but rather as a supplement.
Carah, Meurk, and Hall (2015)	Hello Sunday Morning, Australia	Observational	Recovery social network; online portal that combines website blogging, social media and gamification	HSM attracts a unique group of participants who are more likely to be female, younger and riskier drinkers than treatment seeking populations; males more likely to endorse fitness goals, higher AUDIT scores associated with reduced drinking goals versus abstinence goal; a subset of highly active users generates most content.
Chambers, Canvin, Baldwin, and Sinclair (2017)	Soberistas	Qualitative	Recovery social network site; forums, blogs, webinars and information dissemination—subscription based (paid)	Three distinct activity groups (lurking/voyeur, active participation, leading); participation may work as allowing users to participate in a community that fosters positive identity change, while also allowing for anonymity; lack of support for nonabstinence pathways may isolate users
Cunningham, van Mierlo, and Fournier (2008)	AlcoholHelpCenter.net	Qualitative	Digital website forum	Forum was used to post about a variety of themes, including supporting and encourage content. The use of paid staff moderators may help to increase the quality of content available.
D'Agostino et al. (2017)	OFFOpiates, Reddit Forum	Qualitative	Reddit; anonymous digital website forum	Content created was generally supportive and in line with therapeutic principles; the anonymous

TABLE 2 (Continued)

Author(s)	Location/setting	Design	Characteristics of the digital support	Primary findings/outcomes
				nature of the platform may increase likelihood of honest and open content, as well as protecting identity of users.
Dennis, Scott, Funk, and Nicholson (2015)	Adolescent treatment, United States	Repeated-measures observational	ACHESS smartphone application with ecological momentary interventions	Participants were amenable to using the technology (high completion of EMA rate), recovery support was most often utilized EMI; EMA and EMI were useful in predicting subsequent substance use
Dugdale, Elison, Davies, Ward, and Jones (2016)	Digital platforms recruitment, UK prominent recruitment	Mixed-methods (observational and qualitative)	N/A (prevalence of D-RSS study)	Participants reported varied used of digital supports—Forums most popular digital service (83.33%), most participants had been using online resources for over three years (44.94%), and generally spent over 3 hr per week on the resource(s) (44.94%); evening times and mobile phones were most used to access digital supports. For those in sustained recovery, feelings of giving back were reason for participation most often. Online supports may help serve as linkage and bridge to engaging in in-person supports.
Gonzales et al. (2016)	Adolescent outpatient and residential treatment, United States	RCT	SMS-text messaging (daily self-monitoring texts, daily wellness and recovery tip, and information about substance use on weekends)	After treatment, compared to post-treatment services as usual, SMS-group less likely to relapse (any recurrence of use of their primary substance from baseline) and reported less substance use problem severity and higher likelihood to engage in recovery-oriented behaviors.
Graham, Irving, Cano, and Edwards (2018)	United Kingdom, LIR survey	observational	N/A (prevalence of D-RSS study)	Almost a third have used digital recovery supports (websites, apps, recovery meetings), and usage tends to increase as participants progress in their recovery; suggests using digital to bridge with in-person supports may be beneficial; those employed tended to use websites and apps at greater rates, but less use of digital recovery meetings.

TABLE 2 (Continued)

Author(s)	Location/setting	Design	Characteristics of the digital support	Primary findings/outcomes
Grant and Dill-Shackleford (2017)	Facebook recruitment, United States	Observational	N/A (preference for D-RSS compared with in-person study)	Participants used both in-person and digital supports and preferred the use of in-person supports; greater lengths in recovery associated with greater participation in in-person supports; participants reported it was easier to be honest in in-person supports than digital, though actual dishonest was higher among in-person support contexts.
Gustafson et al. (2014)	Adult treatment, United States	RCT	ACHESS smartphone application with ecological momentary interventions	For the 8 months of the intervention and 4 months of follow-up, patients in the ACHESS group (app + aftercare as usual) reported significantly fewer risky drinking days than patients in the control group; ACHESS group had higher rates of engagement than aftercare as usual.
Kirkman, Leo, and Moore (2018)	Hello Sunday Morning, all countries	Observational	Recovery social network; online portal that combines website blogging, social media and gamification	Participants spent an average of 41 min on platform per day; participation on platform associated with reductions in alcohol consumption with reductions persisting beyond the engagement period; peer to peer connection most beneficial aspect of platform.
Lyytikäinen (2016)	Russia, digital	Qualitative	Digital forum specific to Alcoholics Anonymous	In Russia, where in-person recovery supports are scarce, the digital forum provides an opportunity for individuals to engage in recovery support in a confidential fashion; participation for newcomer's mirrors that of an experience in an in-person AA meeting.
McTavish, Chih, Shah, and Gustafson (2012)	Adult treatment, United States	RCT	ACHESS smartphone application with ecological momentary interventions	Participants with AUD and DUD used application more frequently than those with AUD only, while those with mental health disorders used less (but still 70% at follow-up); rates of use for all participants was high.
Muroff et al. (2017)	Adult treatment, United States	Observational		Participants were likely to continue using application

TABLE 2 (Continued)

Author(s)	Location/setting	Design	Characteristics of the digital support	Primary findings/outcomes
			ACHESS smartphone application with ecological momentary interventions	at follow-up (over 73%), which is a similar rate of usage to the original untranslated ACHESS application.
Sinclair, Chambers, and Manson (2016)	Soberistas	Observational	Recovery social network site; forums, blogs, webinars and information dissemination—subscription based (paid)	46.5% of participants had never used any other support than Soberistas; Anonymity, the ability to be honest, being a source of trusted information, and ongoing support all cited as reasons for continued engagement; used by those in recovery and those still using substances.
Yoo, Shah, Chih, and Gustafson (2018)	Adult treatment, United States	Observational	ACHESS smartphone application with ecological momentary interventions	Rates of giving and receiving emotional support on the application declined over time, though this was moderated by user base characteristics—such as coping skills improving transmission of emotional support, emotional distress hindering it, experienced treatment engagers increasing in giving and receiving over time.

Abbreviations: AA, Alcoholics Anonymous; AUD, alcohol use disorder; AUDIT, Alcohol Use Disorders Identification Test; D-RSS, digital recovery support service; DUD, drug use disorder; EMA, ecological momentary assessment; EMI, ecological momentary intervention; ITR, InTheRooms.com; OA, Overcoming Addiction; OUD, opioid use disorder; RCT, randomized controlled trial; SMS, short messaging service; SNS, social network site; SUD, substance use disorder.

types of D-RSS described across all studies included: recovery social networking sites (R-SNS; n = 5), digital recovery forums (n = 3), smartphone applications (n = 5), short messaging service (SMS) texting (n = 2), public social network sites used for recovery topics (n = 2), and recovery-based websites (n = 1). Participant samples included individuals from the United States (n = 9), United Kingdom (n = 3), Australia (n = 1), Norway (n = 1), and Russia (n = 1) while seven studies had an international focus. The majority of papers were therefore from high-income countries with developed broadband Internet and cellular communication systems. In addition, the majority of the manuscripts (86%) were published between 2014 and 2018, indicating a recent increase in research examining D-RSS.

3.1.2 | Quality assessment

Overall, quality assessment found included studies to have limited experimental outcomes evidence, except for the randomized controlled trial (RCTs) (Campbell et al., 2016; Gonzales et al., 2016; Gustafson et al., 2014; McTavish et al., 2012). However, RCTs were conducted on either the same smartphone application (A-CHESS; Gustafson et al., 2014; McTavish et al., 2012), a novel educational website (Campbell et al., 2016) or SMS text messaging platform (Gonzales et al., 2016), and this higher quality evidence does not translate to other types of D-RSS. Descriptive outcomes (e.g., user characteristics, D-RSS features) were reported in all studies and applicable to recovering populations. D-RSS user perceptions of benefit and engagement rates were not adequately described in all studies or were described in an inconsistent manner when included.

3.1.3 | Characteristics of D-RSS users

Table 3 presents the participant demographics. When gender, ethnicity/race, and age were reported in the reviewed manuscript, gender was near evenly represented (56% female) but the majority of the participants were white (73%) and all but two studies reported on an adult population. Of the studies that did report information pertaining to SUD type of their population, nine study populations included participants who used multiple substances, six study

TABLE 3 Sample characteristics

Author(s)	Participants (size, gender, race, age)	SUD type	Remission status (in treatment, recently discharged, long-term)	Type of recovery modality
Bergman et al. (2018)	N = 2,002; 40% female, 61% white, 46.7 years (SD = 15.3)	All substance use disorders	SUD resolved in past (on average, 11.8 years prior to survey)	Varied
Bergman et al. (2017)	N = 123; 56.9% female, 93.5% white, 50.8 years (SD = 11.6)	All substance use disorders	SUD resolved in past (on average, 7.3 years prior to survey); also included those not currently abstinent and new (less than 1 month) recovery initiates	Abstinence-based
Best et al. (2018)	N = 67, no other demographics	Unknown	Unknown	Unknown
Bjerke et al. (2008)	N = 8, 50% female, no other demographics	Unknown	Recent treatment (residential) discharge, in aftercare	Unknown
Bliuc et al. (2018)	N = 237, no other demographics	Unknown	Unknown	Unknown
Campbell et al. (2016)	N = 189, 60.6% female, 90.4% white, 44.3 years (SD = 10.9)	AUD	New initiates of recovery, unknown treatment status	Smart recovery
Carah et al. (2015)	N = 3,037, 61% female, 36.25 years	AUD	Unknown	Unknown
Chambers et al. (2017)	N = 31, 80.6% female	AUD, other SUD	Unknown	Abstinence-based only
Cunningham et al. (2008)	N = 50, 60% female, no other demographics	AUD	Unknown	Unknown
D'Agostino et al. (2017)	N = 73, no other demographics	OUD	Unknown	Unknown
Dennis et al. (2015)	N = 29, 31% female, 48% African American, 16.6 years	Multiple SUD	Recent discharge from treatment	Abstinence-based
Dugdale et al. (2016)	N = 130, 48.46% female, 45 years	Unknown	Varied (in recovery, not working towards recovery, early recovery)	Unknown
Gonzales, Ang, Murphy, Glik, and Anglin (2014)	N = 80, 43.2% white, 27% female, 20.4 years (SD = 3.5)	Multiple SUD	Recent discharge from treatment	Abstinence-based
Graham et al. (2018)	N = 766, 46.1% female	Unknown	Varied (less than 1 year, 1-5 years, more than 5 years)	Unknown
Grant and Dill-Shackleford (2017)	N = 196, 71.93% female, 86% white,	Unknown	Varied, with most having greater than 1 year of recovery	Abstinence-based
Gustafson et al. (2014)	N = 349, 39% female, 80% white, 38 years (SD = 10)	Multiple SUD	Recent discharge from treatment	Abstinence-based
Kirkman et al. (2018)	N = 1,917, 64% female, 46 years (SD = 11.71)	AUD	Unknown	Abstinence-based
Lyytikäinen (2016)	Unknown	AUD	Unknown	Abstinence-based
McTavish et al. (2012)	N = 349, 39.4% female, 82.9% white, 38.3 years (SD = 10.4)	Multiple SUD	Recent discharge from treatment	Abstinence-based
Muroff et al. (2017)	N = 79, 11.4% female, 100% LatinX, 41.1 years (SD = 8.8)	Multiple SUD	Recent discharge from treatment	Abstinence-based
Sinclair et al. (2016)	N = 432, 94% female, 97% white,	Multiple SUD	Varied lengths in recovery	Unknown
Yoo et al. (2018)	N = 153, 42.5% female, 83% white, 38.40 years (SD = 9.63)	Multiple SUD	Recent discharge from treatment	Abstinence-based

Abbreviations: AUD, alcohol use disorder; SUD, substance use disorder.

populations reported AUDs, and only one focused exclusively on OUDs.

3.1.4 | Mechanisms and features of D-RSS

The manuscripts describe D-RSS operating through several distinct digital platforms, including websites (e.g., Overcoming Addictions; Campbell et al., 2016), open ecosystem social network sites (e.g., Reddit; D'Agostino et al., 2017), closed ecosystem recovery-specific social network sites (e.g., InTheRooms.com; Bergman et al., 2017) text messaging services (e.g., Gonzales et al., 2016), and smartphone applications (e.g., ACHESS; Gustafson et al., 2014). Accessibility and availability of D-RSS appear to vary from publicly available (e.g., Reddit) or private, invitation only (e.g., A-CHESS). Of the D-RSS that are publicly available, the most consistent features available to users are those emulating in vivo recovery supports,

including online mutual aid meetings (e.g., Bergman et al., 2017), peer-to-peer communication forums (e.g., Carah et al., 2015), and social networking (e.g., Sinclair et al., 2016). Private D-RSS (those that have a cost to use, require an invitation, or are not otherwise publicly accessible) contain similar elements as those publicly available, but often contain additional services that are based in professional and paraprofessional service delivery such as psychoeducation (e.g., relapse prevention; (Gustafson et al., 2014).

The way in which D-RSS affect mechanisms that underlie behavior change in recovery have not been distinctly characterized in the literature, however, services appear to be similar to mutual aid recovery supports (e.g., Alcoholics Anonymous; Kelly et al., 2008; Kelly et al., 2009) and in vivo RSS (Kelly & Hoeppner, 2015). While some D-RSS directly emulate in vivo recovery supports (e.g., by offering online mutual aid meetings), others have created peer-to-peer social networking and resource sharing based in social identity models of recovery (SIMOR; Best et al., 2016, 2018) and peer-based recovery models (White, 2009).

3.1.5 | D-RSS feasibility, utility, and efficacy

Among D-RSS, feasibility appears to be favorable, as several studies highlight low attrition and high engagement among participants that begin using the services (Bergman et al., 2017; Gustafson et al., 2014; McTavish et al., 2012; Sinclair et al., 2016). Only four number of studies were experimental, with the majority being observational designs that did not examine effects of D-RSS participation, but rather describe change over time (i.e., longitudinal) or ask participants to report retrospectively at one point in time (i.e., cross-sectional). Of those with an experimental design, websites, text messaging services, and smartphone applications were studied (Campbell et al., 2016; Gonzales et al., 2016; Gustafson et al., 2014; McTavish et al., 2012). Among these, engagement and participation had a positive effect on percent days abstinent from the individual's primary substance, percent days risky drinking, and reduction in alcohol-related consequences. Observational studies on R-SNS and public social networking sites found relationships measured cross-sectionally (i.e., correlations) between D-RSS use and high satisfaction (Bergman et al., 2017; Kirkman et al., 2018), improved social support (Sinclair et al., 2016; Yoo et al., 2018), perceived benefit from using the service (Bergman et al., 2017), and reductions in stigma (Bliuc et al., 2018). Additionally, observational studies highlighted that engagement and benefit may be moderated by participant characteristics such as recovery length and recovery pathway (Bergman et al., 2017; Graham et al., 2018), suggesting that utility and efficacy of specific D-RSS may vary between different participant types.

4 | DISCUSSION

Overall, we can conclude that several types of D-RSS exist, including websites, public social networking sites, recovery-centric social network sites, text messaging services, and smartphone applications.

D-RSS also have been used to provide support for a range of SUDs, including opioid use disorder and alcohol use disorder. However, because few studies employed a design rigorous enough to determine whether the D-RSS under study was effective (e.g., experimental or quasi-experimental), evidence for the effectiveness of D-RSS is limited. From the experimental evidence—limited to the smartphone-based app ACHESS and SMS-based D-RSS for adolescents—we find that D-RSS participation promotes reductions in risky substance use and client attrition. Other non-smartphone-based D-RSS have yet to be experimentally studied and little is known about their comparable efficacy. Observationally, engaged participants report high levels of satisfaction and perceived benefit, often for the D-RSS delivered on R-SNS platforms.

While reviewing the findings, it is important to contextualize the absence of experimental evidence for D-RSS. Specifically, D-RSS have emerged within the past decade as the technologies they leverage (e.g., smartphone applications, SNSs, etc.) have become more widely available. While D-RSS often appear to emulate in vivo RSS such as mutual aid and peer-to-peer networking, it is not possible at this time to estimate their effectiveness in isolation or compared to other recovery supports. Future studies of D-RSS should employ experimental designs with comparison groups of in vivo recovery supports and alternative D-RSS, as well as those who receive no services. For instance, video conference recovery coaching sessions may be compared with in-person recovery coaching sessions, or online mutual aid meetings may be compared with in-person meetings; where both studies would have a third comparison group of individuals receiving no services. It is imperative that findings from such future studies report the magnitude of D-RSS effects (including the magnitude of the effects ideally in real world metrics, in addition to statistical significance), a recommendation that has also recently been made in a systematic review of in vivo peer-based RSS (Bassuk, Hanson, Greene, Richard, & Laudet, 2016).

While D-RSS are similar to in vivo RSS, differences do exist. For example, a primary feature of D-RSS feasibility is the delivery of on-demand support that is not hindered by traditional obstacles found in in vivo supports: transportation difficulties, ability to pay, or local geo-availability. It is feasible that for individuals who are hesitant to engage in in vivo supports, that naturally have a higher threshold of engagement as mentioned, engagement with a D-RSS may be more appealing due to the low threshold nature. Such a phenomenon may help to broaden the base of RSS and provide another entry way into the recovery process. Lower income individuals were more likely to have lifetime history of D-RSS engagement in the national recovery study sample (Bergman et al., 2018), which also suggests that D-RSS may serve as a lower threshold option, especially for those with less financial resources. However, we note that D-RSS engagement does require access to technology and such a requirement may limit the number of individuals who can or choose to engage. A recent study of outpatient SUD treatment clients found over 70% had regular access to the internet, with 80% of those accessing the internet primarily through a smartphone (Ashford et al., 2018). Ownership of a smartphone was associated with age however, with participants over

the age of 52 years less likely to own a smartphone compared to those under 52 years. As such, consistent accessibility to the internet, and thus D-RSS, may be limited. This may suggest too, that D-RSS may have greater utility for certain demographic subgroups than others.

Another example of difference is the diversity of recovery supports available on a single D-RSS platform. Some D-RSS offer peer-to-peer networking (social or forum-based), online mutual aid meetings, and resource and information distribution (Bergman et al., 2017), whereas others combined smartphone technology to offer asynchronous education, peer-to-peer networking, and the ability to reach out for support via telephone or text message (Gustafson et al., 2014). However, as stated, the utility or effectiveness of multiservice offerings on a single platform has not been evaluated, and while it is a noted difference, it may not be a therapeutically relevant one. Even if multiservice offerings are not therapeutically beneficial, previous research has found that individuals engage in SUD treatment self-reported a desire for different features in digital applications to support their recovery (Ashford et al., 2018). Offering an array of services may be beneficial to drive adoption and usage of the platform, and should be considered whether or not individual-level benefits are an effect.

Similar to the ability of D-RSS to offer multiple service options at once, some D-RSS offer supports to a range of demographically diverse individuals. For example, InTheRooms.com offers online mutual aid meetings for specific segments of the engaged population, including veterans, women, young adults, LGBTQ+, and others (Bergman et al., 2017). This feature of D-RSS may prove useful in future expansion and adoption, as creating such diverse offerings may be easier on digital platforms than it would be for in vivo supports due to both potential fiscal constraints, and as the extended (even national or global) reach of D-RSS means that for smaller subpopulations a critical mass of individuals can be obtained more readily than it might be in a clinic setting. Currently, findings suggest that this diversity does not often include recovery modalities (e.g., abstinence-based, moderation, medication supported, etc.), at least among available reports of current D-RSS. While it is unknown if D-RSS will be created to serve diverse recovery modalities in the future (or currently exist but remain unexamined), it is plausible that they have the ability to do so. Publicly available D-RSS, especially those operating in open ecosystems such as Facebook or Reddit, may serve multiple recovery objectives and goals and be specialized, as discussed, for specific segments of the population. This possibility requires future empirical examination, and should consist of study on multiple forms of D-RSS.

D-RSS may also be used differently and for different reasons depending on the characteristics of the individual. For example, length in recovery was found to moderate engagement and perceived benefit in one R-SNS (Bergman et al., 2017), and smartphone D-RSS have been primarily deployed to those early in the recovery process (i.e., immediately after discharge from treatment settings) (Dennis et al., 2015; Gustafson et al., 2014). Further examination of how, why, and to what extent individuals engage with specific D-RSS types is needed, which may help future D-RSS creators, clinical providers, and

recovery support providers to refer individuals to the most appropriate and potentially beneficial D-RSS. Not all D-RSS were used only by individuals typically considered to be "in recovery," which suggests that D-RSS may not only be a viable RSS, but also provide a mechanism for those wanting to modify problematic substance use for wellness purposes.

4.1 | Future considerations

Several considerations should be attended to in future study of D-RSS. D-RSS have been used by several distinct populations, including those that have sought out clinical SUD treatment services and those that have not; those following myriad recovery modalities; those in or seeking recovery from varied SUDs including alcohol, opioid, cannabis, and other substances; and those with identities that contribute significantly to the support networks they wish to engage with (e.g., gender, LGBTQ+, veterans, etc.). As such, pathways to engagement may moderate effects and outcomes and should be considered in all future research. Additionally, as D-RSS can be delivered on-demand, dose–response relationships may be hard to quantify but will be critical to illuminating the effects of D-RSS participation and engagement. Dose may also be considered as intentional engagement (i.e., commenting, posting, attending online meetings) or as voyeurism (i.e., accessing the platform only to read but not taking specific actions) which may also have benefits. The degree to which these different intensities of engagement differ should be examined, as well as theoretical development of how such engagement promotes behavior change or resilience in the recovery process. D-RSS offer an advantage to researchers in that both objective data (e.g., non-self-report digital activity such as time spent online, number of actions taken, etc.) and self-report data can be collected. Augmenting self-report data with objective data from D-RSS participants may add to the predictive value of current and future models of recovery behaviors and outcomes, though future studies will need to examine this possibility empirically. For future research designs, we recommend making use of a multiphase optimization strategy framework (MOST; Collins, Murphy, & Strecher, 2007; Collins, Nahum-Shani, & Almirall, 2014) so as to make sequential progress in the evaluation of D-RSS, where previous studies inform the next and make efficient use of researcher resources (fiscal and human) and participant resources (experiment fatigue). The MOST framework can also assist researchers in determining whether a randomized trial or other experimental method (e.g., quasi-experimental) is viable, which can help to move forward research on D-RSS that are publicly available for anyone to access.

5 | CONCLUSION

While evidence for clinical and public health utility of D-RSS is limited at this time, a range of D-RSS exist that are being used by individuals in SUD recovery. This may be due to D-RSS filling an availability and accessibility gap not filled by in vivo supports, or otherwise providing an easily accessible support service that can augment in vivo supports.

The latter notion is supported by observational findings that those engaging in any D-RSS in their lifetime also engage with in vivo supports. Future research is needed on the types, scope, contents, dosing, duration, context and effects of all D-RSS, compared with in vivo supports and other D-RSS, prior to any recommendations for individual use being made. Opportunities for expansion of the current recovery support infrastructure, which is lacking, provide a basis for the continuing examination of D-RSS. Given that cost, availability, and easy accessibility, are major factors affecting the likelihood someone needing a service will engage with and benefit from it, the free or low cost and extended reach of D-RSS may mean that the overall public health dividends could be large even if the magnitude of the average effects are relatively small.

ACKNOWLEDGMENTS

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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