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Dyadic digital health interventions: Their rationale and implementation

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Abstract

While most psychosocial and behavioral digital health interventions have been designed to be consumed by an individual, intervening at the level of a dyad – two interdependent individuals – can more comprehensively address the needs of both individuals and their relationship. The clinical utility of the dyadic digital health intervention approach, as well as the practical implementation of this design, will be demonstrated via three examples: eSCCIP, FAMS, and OurRelationship.

Keywords: dyads; couples therapy; family therapy; digital health; eHealth; mHealth

1. Introduction

Internet usage is largely an independent activity. Devices like smartphones, laptops, and tablets are generally designed for use by one individual at a time. Psychology and medicine have also largely focused on the individual

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mind and body, with treatments typically delivered to an individual 'patient.' With these technical and clinical parent fields focusing on the individual, it is logical that digital health interventions have also been largely designed to deliver care to individual patient-users.

There is a rising appreciation, however, that an individual's health, coping, and behavior do not exist in isolation, but are influenced by the individual's social environment. In fact, support from close loved ones is often critical to individuals for successfully coping with everything from work stresses to severe physical illnesses, an "emotional system" process defined by dyadic stress theory [1,2]. Addressing the coping skills and psychosocial needs of these close-others is therefore important, as the well-being of the individual depends on the abilities of the close-other to provide support. In addition, certain problems only exist for individuals in the context of others – like distressed couples or families. Expanding care beyond the individual – for example, to a *dyad* of a person managing a health condition and their closest supporter, or a distressed couple – could more comprehensively address many behavioral health concerns.

Intervening with two individuals together, however, can compound difficulties in accessing care. For instance, practical barriers that commonly interfere with psychosocial care access like scheduling and transportation difficulties are doubled when two individuals need to join an appointment together [3,4]. Moreover, there is a unique financial barrier to dyadic care, given that there are significant gaps in insurance coverage for dyadic interventions and interventionists [5,6]. Delivering care to dyads by the Internet with partial or full automation can alleviate these barriers by making care more cost-effective and available anywhere and anytime the Internet is accessible. Interventions delivered via telephone and text messaging can reach even more individuals. Indeed, these accessibility and cost benefits of delivering care to dyads through their digital devices could address about half of the identified major barriers to distressed couples seeking couple therapy [7].

The digital health literature also reflects an increasing interest in intervening with dyads. A 2020 scoping review of e/mHealth interventions targeting dyads of patients and their family caregivers found a rapid rise in publications on this topic: while it took ten years to see 35 publications in this area from 2003 to 2013, there were 35 publications between 2017 and March 2019 alone [8]. In the couple therapy literature, reviews have likewise demonstrated strong research interest in delivering care to couples through telehealth [9] and more automated Internet interventions [10,11]. Across dyadic digital health interventions, there has been a diverse approach to intervening with the dyad – some intervene entirely with the two individuals together (e.g., [12,13]); some deliver all care to individuals separately (e.g., [14,15]); and others take a hybrid approach with some shared and some individual components (e.g., [16,17]).

Depending on the approach to intervening with the dyad, the technical execution of such interventions can be complex. Even at its simplest, where all intervention content is delivered jointly to the dyad members together, challenges of engaging, scheduling, and assessing two users (instead of one) arise. Differentiating the intervention content between the two dyad members – for example, to more uniquely address parent versus child, or medically ill individual versus family caregiver – can increase development time, complexity, and costs. Researchers must also carefully consider the dyads' journey through the intervention: should participation be 'yoked' between individuals, meaning one user can only progress when their respective partner has completed certain actions? Will one user's intervention be tailored based on the data entered by their respective partner? Is there potential harm done by reporting progress, actions, or perspectives of one member of the dyad to the other? What is the theoretical rationale for each of these decisions and their ethical implications?

These interdependent technical, theoretical, and ethical considerations can be daunting, especially when one considers the complexities of developing digital health interventions even for individuals. Still, there is significant clinical importance of delivering care to dyads, and digital health has unique potential to actualize this care in a scalable and accessible way. Towards this goal, we present three examples of dyadic digital health interventions: eSCCIP, an eHealth intervention for parental caregivers of children with cancer; FAMS, a mHealth family systems theory intervention to support diabetes self-management; and OurRelationship, a comprehensive online program for relationally-distressed couples. These three examples were selected as they each take unique, theory-driven approaches to intervening with dyads aligned to best address their clinical goals. For each intervention, the rationale and practical approach for intervening with the dyad is presented, along with data regarding intervention impact. Through presenting

this information, our aim is for digital health researchers to consider the potential clinical utility and technical capacity of their interventions to address a dyad.

Nomenclature

eSCCIP	Electronic Surviving Cancer Competently Intervention Program
PCC	Parents and other primary caregivers of children with cancer
FAMS	Family/friend Activation to Motivate Self-care intervention
SP	Support person
T1D/T2D	Type 1 Diabetes / Type 2 Diabetes
RCT	Randomized controlled trial
OR	OurRelationship program
Dyad	A care unit of two close individuals. For instance, a dyad may comprise a romantic couple (target of care by OR), an adult managing a chronic condition and their SP (target of care for FAMS), or two caregivers of a child (target of care for eSCCIP).

2. eSCCIP

The Electronic Surviving Cancer Competently Intervention Program (eSCCIP; pronounced e-skip) is a psychosocial eHealth intervention for parents and other primary caregivers of children with cancer (henceforth referred to as PCC). The intervention consists of a combination of asynchronous online modules, which include video and interactive content, and brief telehealth sessions with a trained interventionist, focused on reviewing and discussing the asynchronous content [18]. eSCCIP is based on the in-person Surviving Cancer Competently Intervention Program—Newly Diagnosed (SCCIP-ND) intervention and pulls from cognitive-behavioral therapy and family systems theory [19]. eSCCIP was developed using user-centered design principles and has undergone rigorous pilot testing [18,20]. A key benefit of eSCCIP is the flexible and adaptable nature of the intervention, designed to meet the needs of PCC during a period of high stress and elevated psychosocial risk [21]. For example, PCC are encouraged to complete one module and one telehealth session per week, but the pacing of the intervention can be adjusted to accommodate scheduling or other conflicts. PCC can complete the intervention sessions anywhere that they have Internet access, including mobile data access, as the web-based platform is mobile-friendly.

The theoretical underpinnings of eSCCIP recognize the impact of a pediatric cancer diagnosis and treatment course on the entire family system [18,19,22]. Despite the recognized importance of supporting PCC, there are a number of logistical and psychosocial challenges associated with enrolling parents in parent-focused interventions during their child's cancer treatment [19,23]. Efforts to enroll dyads in an in-person SCCIP-ND trial were stymied by a number of difficulties (e.g., scheduling conflicts, elevated parental distress) [23], and no other eHealth interventions exist for dyads in the pediatric psychosocial oncology sphere [8]. In order to meet the needs of all PCC, balancing the potential benefits of dyadic enrollment against the challenges associated with dual participation, eSCCIP can be used both by dyads and by individual PCC. This decision increases the reach of the program, for example, to single parents or to parents with an uninterested partner. It also alleviates a key ethical concern, where an interested PCC will not be denied access to the program just because their partner is not interested in participating. A focus on the family system is maintained for PCC who enroll as individuals (e.g., examples reviewed in telehealth sessions are focused on the family unit, all modules feature videos of other PCC discussing their experiences with cancer and its impact on the family unit).

Dyads who do choose to participate together do not need to be romantic couples or co-parents, for example, a parent and an adult sibling who cares for the child with cancer can participate together as a dyad. Participants' preferences are prioritized on how the dyad members would like to participate together (or not). For example, enrolled dyads are permitted to complete the full intervention separately, or they can complete components (e.g., telehealth sessions) of the intervention together. Dyad members have their own unique accounts for accessing the asynchronous material so they may progress through the program at their own pace.

Two separate pilot studies of eSCCIP have been completed [20,24]. Across these trials, 14 dyads (n = 28 participants) in total enrolled; however, only 8 of these dyads (n = 16 participants) completed the intervention. Together with the individual users enrolled without a dyad member, a total of 50 participants have completed the intervention. Overall results from these trials have been promising, with over 80% of completers rating the intervention as highly acceptable and feasible. Exploratory analyses have also shown reductions in psychosocial outcomes of interest, including symptoms of posttraumatic stress, negative mood and cognitions, anxiety, and acute distress.

Across enrolled dyadic participants in the two pilot studies, twelve dyads were mother-father pairs and two dyads were mother-adult sister pairings. Levels of family psychosocial risk as measured by the Psychosocial Assessment Tool [25] for each PCC at baseline were the same for seven dyads and discordant for the remaining seven dyads. In a qualitative study assessing strategies to improve recruitment, retention, and engagement, which included individual PCC and dyads, PCC provided several suggestions specific to dyadic enrollment and retention. For example, they noted the importance of approaching and offering participation directly to each eligible PCC in a family and continuing to be maximally flexible with scheduling the different components of eSCCIP [26]. A multisite randomized controlled trial [RCT] is newly underway to evaluate the efficacy of eSCCIP in English- and Spanish-speaking PCC.

3. FAMS

For adults with diabetes, regular self-care behaviors – for example, healthy diet and regular exercise – are essential for glycemic management (i.e., hemoglobin A1c; HbA1c) and to help prevent complications and comorbidities. Theoretical and observational evidence indicates that engaging family and friends in diabetes self-care has the potential to enhance or sustain behavior changes [27–29], although this promise has not yet been realized in interventions, as effects of family interventions have been small and inconsistent [30–33]. One potential reason for this may include a lack of attention to the harmful aspects of family involvement [30,31], which has been linked to less self-care [34,35] and worsening glycemic management over time [34]. Another potential reason may be that interventions have focused on a single relationship, rather than equipping the person with diabetes with skills to manage numerous relationships (e.g., friends, family, community members, and coworkers) in relation to daily self-management.

Family/friends Activation to Motivate Self-care (FAMS) is a technology-supported diabetes self-management intervention [36,37] informed by family systems theory [38]. This theory posits that when an individual introduces a behavior change, responses from family/friends serve to reinforce or undermine that change over time, creating a feedback loop. Accordingly, interventions that attend to amplifying reinforcing feedback (e.g., instrumental support, encouragement) and reducing undermining feedback (e.g., sabotaging, criticizing, nagging) from family/friends may be more effective in sustaining health behavior change than interventions directed only at individual change. FAMS prompts individual behavior change by assisting the person with diabetes in initiating and monitoring progress with personalized self-care goals and by equipping them to manage feedback loops by learning skills to anticipate, shape, and manage responses – both helpful and harmful – received from family/friends as they meet their new goals [36]. FAMS does this with three components: monthly coaching, daily text messaging support, and optional engagement of a support person (SP). For persons who choose to invite a SP, SPs also receive text messages designed to increase dialogue and prime conversations in which the person with diabetes can apply skills learned in coaching. SPs' text messages are also tailored to the person with diabetes' goals broadly, but do not "report out" regarding the person's goal specifics or progress. In addition, SPs receive a weekly message prompting them to reflect on their support for the person with diabetes.

FAMS is designed to target family/friend involvement in diabetes self-care goals regardless of enrollment of a SP. The intervention's skill building component, delivered in each monthly coaching session, develops skills to engage multiple family/friends, including building new relationships or managing exchanges about health goals in existing relationships. The coaching sessions focus on multiple different relationships, not just the enrolled dyad if a SP is invited. For people who already have a willing SP, the intervention has an additional component to support and leverage this key relationship. This design choice was made because people who do not have an available and willing SP may be most in need of the skills and support FAMS provides, to honor diverse perspectives on enrolling an SP, and to prioritize the autonomy of persons with diabetes [39]. For people who invite a SP, FAMS places no restrictions on the nature of that relationship other than that the SP is an adult using a different mobile phone than the person with

diabetes. This decision was made considering the growing number of adults living alone, nationwide and particularly among minoritized racial and ethnic groups [40,41]. This decision also reflects the prevalence of long-distance caregiving and frequent contact between persons with diabetes and adult offspring who live separately [42,43].

FAMS has been examined among racially and socioeconomically diverse adults with Type 2 Diabetes (T2D; usability testing [37] and pilot RCT [36]) and among emerging adults with T1D (pilot feasibility study [44]). In both groups, FAMS had high feasibility and acceptability. Among diverse adults with T2D, FAMS was evaluated in a three-arm RCT [36,45] in which participants were assigned to receive enhanced treatment as usual (control), a text messaging intervention (called REACH) addressing medication adherence, or REACH + FAMS. Compared to the control group, participants assigned to REACH only had improved self-efficacy and dietary behavior but did not have changes in family/friend involvement. Participants who received REACH + FAMS not only had improved self-efficacy and dietary behavior, but also had improved family/friend involvement. At baseline, relative to persons who did not enroll a SP, those who did were younger, more likely to be married/partnered, and reported more depressive symptoms, more helpful family/friend involvement, and more emergency department use [46]. Reasons for inviting a SP included recognizing a need for more help and seeing benefit to involving others; reasons for not inviting a SP included concerns about being a burden, preferring autonomy/privacy, and not having anyone to invite [46]. When we examined FAMS effects by SP enrollment, similar intervention effects were found on self-efficacy and dietary behavior regardless of SP enrollment. However, persons with an enrolled SP experienced increased helpful involvement and persons without an enrolled SP experienced reduced harmful involvement. Findings suggest people may be wise in their SP invitation choice, with those who already have a helpful SP and are desiring more helpful involvement choosing to invite a SP.

Both intervention groups (REACH only and REACH + FAMS) improved HbA1c at 6 months [47]. Importantly, REACH + FAMS effects on family/friend involvement mediated sustained improvements in HbA1c at 12 months, whereas REACH only effects on HbA1c were not sustained at 12 months and there was no family/friend involvement mediation effect [48]. While preliminary, this finding supports the hypothesis of family systems theory that behavior change accompanied by improved family/friend involvement may sustain behavioral changes, leading to longer-term reductions in HbA1c. Currently, an effectiveness RCT is underway comparing FAMS relative to enhanced treatment as usual on adults with diabetes' HbA1c and diabetes distress, as well as on their SPs' diabetes distress [49]. The research team is also preparing to start a similar effectiveness RCT among emerging adults with T1D and their SPs.

4. OurRelationship

The experience of romantic relationship dissatisfaction is as common as it is detrimental to those struggling. Estimates suggest that more than one in three couples experience clinical levels of relationship maladjustment [50], and its impact on domains of functioning is widespread [51]. Fortunately, extant research continually demonstrates the efficacy and effectiveness of traditional couple therapy across theoretical approaches (for review, see: [52]). However, most distressed couples – especially those from under-resourced populations – are unable to access or otherwise do not receive couple therapy [53].

Fortunately, online interventions for distressed couples overcome many of the barriers to traditional therapy. Couples previously unable to receive high-quality, empirically supported treatment have access to greatly reduced or no cost interventions that can be completed in a fraction of the time via most mobile devices. The OurRelationship Program (OR; [54]), is a web-based, secondary prevention program for couples experiencing relationship distress. Based on Integrative Behavioral Couple Therapy (IBCT), a form of in-person couple therapy with strong empirical evidence [55], OR can be completed in 8-10 hours over the course of 6 weeks. The program has three sections comprising the *OUR* acronym. Couples *Observe* tailored feedback to aid in identifying a central relationship problem; work to *Understand* that issue from a more objective, unified perspective; and finally, armed with a greater understanding, *Respond* to that issue through emotional acceptance, behavioral exchange, and problem-solving techniques. To aid in program retention and effectiveness of intervention strategies, couples can choose to work with a coach who meets with the couple virtually for five, 20-minute appointments throughout the program.

The standard version of OR is designed to centrally involve both partners, as gains in relationship functioning are typically greatest when both partners are working to improve their relationship. An underlying assumption of OR (and IBCT) is that relationship distress often results from a polarization process [56] in which each person's attempts to

change the other inadvertently causes that partner's behavior to become more extreme or maladaptive. Therefore, if OR can increase each member of the dyad's understanding and acceptance of the partner, it can reduce polarization. In contrast, when only one member of the couple participates in OR, that person needs to not only change their proactive behavior towards their partner, but also inhibit their problematic reactive behavior in response to the partner's continued provocations.

To work effectively with the dyad, OR was designed with three key considerations in mind. First, most of the online content in OR is viewed individually by each person. This structure allows users to thoughtfully reflect on their relationship, reduces the likelihood of arguments, and allows for differences in reading speed and schedule availability. Second, as users view program content on their own, OR asks each partner to independently save key responses or choices into the program. In the *Understand* section, users are asked to develop a DEEP understanding – how natural *D*ifferences, *E*xternal stress, hidden *E*motions, and *P*atterns of communication cause or exacerbate their relationship difficulties. For example, in the Patterns section, users learn about common communication styles and select the communication behavior that they and their partner are most likely to do during and following conflict. Similarly, in the *Respond* section of the program, users see tips tailored to their specific patterns and are asked to consider how they might change their own behavior, as well as how their partner could change. Third, the program and the coaching calls are structured to allow the dyad to come together during several points to share with one another what each has written. Using a speaker-listener structure, each partner takes turns as the speaker to share components of the DEEP understanding or potential solutions. During the speaker turn, what the user wrote during the program is displayed on the screen to help them remember what they decided (and to hopefully avoid blaming language).

However, it is not always possible to intervene with the couple together. Indeed, more than half of potential users who express initial interest in the OurRelationship program have partners who do not complete their enrollment form. Furthermore, people whose partners did not complete the enrollment form had lower levels of relationship and individual functioning [57]. To ensure that the OR program is available to as many people as possible, there is a version of the program that individuals in relationships can complete on their own [58]. Unlike the dyadic version, users rely on their assumptions of how their partner would respond, rather than their partner's actual responses to key constructs. In place of the guided conversations that take place in the dyadic version, users are provided letter templates and ideas about how to introduce the ideas learned in OR in a more naturalistic conversation with their partner.

In four separate RCTs involving over 2,000 couples [54,59–61], the OR program has consistently been found to result in medium to large improvements in relationship satisfaction, communication conflict, breakup potential, and many other aspects of relationship functioning (for overview, see: [11]). Furthermore, although the program focuses on the relationship, it has consistently shown significant improvements in participants' both mental and physical health – especially within subsamples of individuals who reported difficulties in those areas at baseline [11]. Within these subsamples, for instance, the program created substantial medium to large improvements in depressive symptoms, anxious symptoms, perceived stress, perceived health, insomnia, and problematic alcohol use. These improvements in relationship and individual functioning, in turn, yield significant program effects on co-parenting conflict, parenting behaviors, child emotional problems, and child behavior problems [62]. Furthermore, while results from a RCT of the OR individual version with 90 individuals showed significant between-group effects on several individual functioning domains but not relationship functioning, the effects of the couple and individual versions did not significantly differ in demographically- and relationally-matched samples of couples and individuals [58]. In summary, the OR program has consistently demonstrated an ability to positively impact a wide range of relationship and individual domains.

5. Discussion

While each of the eSCCIP, FAMS, and OurRelationship interventions share a dyadic digital health approach, their clinical rationales and technical approaches to intervening with dyads differ. Chosen from among a broad array of existing dyadic digital health interventions [8–10], comparing and contrasting these three interventions illuminate points of consideration for researchers interested in this intervention delivery design. Specifically, each of the discussed interventions clearly stipulates a theoretical rationale for intervening with a dyad and aligns the technical execution of the program with that rationale, while also accommodating single users into their programs.

While advocating for researchers to consider a dyadic approach, this approach should only be considered where there is a strong clinical and theoretical rationale for intervening with two individuals as opposed to one. The clinical

imperative of intervening with both members of a distressed couple that justifies the dyadic approach for OR is perhaps the clearest case of the three outlined interventions. The dyads' user journey through the OR program has been thoughtfully aligned with its therapeutic paradigm (IBCT), as well as practical concerns of the targeted user base. Specifically, partners each have their own program logins to complete the asynchronous components of the program privately, and at their own pace, while synchronous homework activities and videoconference sessions bring the couple together for guided interaction. The OR team has carefully chosen which user input is shared, when, and under what conditions according to what will be most clinically useful for transitioning partners from individual perspectives of their relationship problems (which are often flawed, incomplete, and blaming) towards a shared and objective definition of these problems. Certain assessment data is shared between partners to help them better understand one another (e.g., describing and comparing each partner's personality characteristics and current stress); however, other information is only shared between the couple once they have been prepared to have a constructive conversation regarding the material. With more than ten years of study and $14 million USD in U.S. federal funding, the OR program represents one of the most well-established dyadic digital health programs.

eSCCIP targets dyads given the clinical best practice in pediatric cancer to engage the family system in psychosocial care. Intervention content directly addresses how family systems are affected when a child becomes ill, and how families may cope effectively together. An important practical consideration by the eSCCIP researchers was to define the dyad broadly for a highly inclusive care approach, namely, any two adults who share caregiving responsibilities for a child with cancer. In addition, this intervention also emphasizes more flexibility in delivery to the dyad, where dyad members can advance through the intervention at different paces and may choose to attend video sessions together or independently. This flexibility is important in the clinical context to accommodate each participant's needs during a severe life stressor.

FAMS is an excellent example of how a dyadic approach can meaningfully improve upon traditionally individually-focused care (i.e., health behavior change for adult diabetes management). Given the strong helpful and harmful influences of families on adults' diabetes self-management behaviors, researchers addressed a significant unmet need among their targeted clinical population through directly intervening on this support process. In this intervention, dyads of an adult with diabetes and a chosen support individual have distinct intervention content and experiences: The person with diabetes receives education about how to elicit desired support for their health behavior changes (and how to cope with negative feedback), while the supporter receives education about the person with diabetes' health goals and how to be an effective supporter. Importantly, incorporating the support person is not only intended to benefit the person managing their diabetes, but also can have important benefits to the supporter themselves. Loved ones of individuals with medical illness often desire, but rarely receive, training in how to provide effective support, and this need is met by the FAMS intervention.

Even though each of these programs have clear rationales for intervening with dyads and have developed their programs to do so, each can also effectively accommodate single users. The intervention content and user journey for each of these interventions is largely similar for individual users as those enrolling with a dyad member, although without the opportunities for joint video appointments or facilitated support from a close individual. This decision is rooted in the theoretical rationale for these interventions – that the broader relationship or family system impacts the coping and behavior of the individual user. While this rationale emphasizes the importance of engaging the full system in care, not every individual who could benefit from this care will have a partner/supporter willing or able to participate with them. Ethically, it is important to ensure these individuals are not denied care where it is appropriate and is likely to be beneficial. Indeed, OR researchers have found that couples where only one individual sought to enroll in the program were more distressed than those where both individuals were willing to enroll, suggesting the importance of extending care to individual users. FAMS researchers, too, theorized that those adults who did not have a supporter to enroll may be in most need of the social support activation intervention, and their empirical data suggests the importance of leaving this choice to invite a supporter up to the individual who is best suited to determine if anyone may be helpful to their lifestyle changes. Moreover, both of these interventions demonstrated that individuals can benefit from their interventions focusing on relationship processes, even when a close individual is not available to co-participate. Consequently, creating an individual pathway through dyadic interventions is important for reach, and therefore ultimate population-level impact of these interventions.

5.1. Future research directions

There is strong theoretical and clinical rationale for intervening with dyads for many behavioral and relational concerns, and there is strong empirical evidence supporting many dyadic digital health interventions as well. Given the challenges associated with these interventions, however, more evidence is needed regarding under what circumstances intervening with the dyad is superior to intervening with individuals – and why this is the case. Interventions designed to be delivered to individual users may still incorporate content designed to activate social/relational support without specifically enrolling supportive others into the program. In other words, interventions may choose to have more individual-focused or broader social system-focused content, with a separate choice regarding individual or dyadic delivery. Better understanding which dyads under which circumstances benefit most from incorporating both users into care will help justify disseminating these interventions. Towards this end, secondary analyses are planned in the ongoing eSCCIP RCT (dependent on enrollment of dyads vs. individual PCC) to explore the impact of participating along with a dyad member as opposed to participating on one's own. Particularly where dyads are enrolled to solicit the support of a care partner, researchers are encouraged to assess the (helpful and harmful) effects of the intervention on each individual, so the full impact of the intervention is understood. For example, the current FAMS RCT is addressing this need by measuring how the intervention may also directly improve the well-being of the support person. This data regarding the benefits and costs of interventions to each type of participant should be factored into decision-making regarding whether care is delivered to dyads versus individuals.

One area of particular significance to digital health is how participating in a digital health intervention as part of a dyad, instead of individually, might impact engagement. As engagement with fully-automated interventions is often suboptimal, digital health interventions often incorporate human clinical support to improve adherence. Enrolling dyads into an intervention may similarly support engagement through increased interpersonal accountability. For OR, there has been a small difference between user completion rates of individuals versus couples: while 80% of individual users completed the intervention [58], 85% of couples completed the intervention [54]. Qualitative data from FAMS participants who chose to nominate a support person also supports the potential utility of dyads to support engagement, with participants describing that they wanted a supporter enrolled to "have some type of encouragement" and because "it helps to remind me to stay on task" [46].

Dyadic interventions will also benefit as technical capabilities of digital health platforms continue to mature. Platforms that allow dyad members' separate interventions to 'speak' to one another could help provide more targeted interventions (e.g., by tailoring a supporter's intervention based on a patient's reported symptoms) or support engagement (e.g., with shared 'streaks' based on both users' behavior). For interventions utilizing smartphones, dyadic just-in-time interventions may be triggered based on sensors such as geolocation (e.g., pinging a long-distance caregiver when a patient arrives to the doctor's office to send a support message) or Bluetooth pairing (e.g., reminding a couple to have a planned conversation when they were next together). Each of these decisions, however, must continue to be made based on the theoretical and clinical reasons for why the dyad is targeted. Moreover, the ethical ramifications of these decisions must be considered, as well as whether there is any potential to cause harm. For example, the OR team has aligned decisions regarding what information is shared across platforms – as well as when and under what circumstances – with their programmatic clinical goals. Specifically, selected information is shared once couples are likely to address that information together constructively and not argumentatively. As conducted for each of the three interventions in this article, thorough and iterative user-centered design and feasibility testing is particularly important for dyadic digital health interventions given their complex technical execution and social impacts.

5.2. Conclusions

Individuals' coping, behavior, and health are heavily influenced by their closest relationships. Addressing these relationships within digital health interventions can therefore more comprehensively promote individuals' well-being. There are significant theoretical and clinical issues to consider, however, before deciding to intervene with a dyad instead of an individual alone. Where the potential benefits (ideally for both dyad members) outweigh the potential costs (like participant effort and development burden) of intervening with the dyad, researchers then must ensure the

technical delivery aligns with the theory and clinical wisdom motivating dyadic delivery. While this may be daunting, examples presented here illustrate a variety of ways that dyadic delivery has been accomplished for digital health interventions. Interdisciplinary collaboration between dyadic intervention scientists, software engineering, and user interface/user experience designers will be important for dyadic interventions to continue to mature and realize even more timely and effective interventions.

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