Journal of Clinical Psychology in Medical Settings (2019) 26:68–87
https://doi.org/10.1007/s10880-018-9565-8

Technology-Focused Family Interventions in Pediatric Chronic Illness: A Systematic Review

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Abstract

This systematic review provides a synthesis of randomized-controlled trials of technology-focused family interventions for children with chronic illnesses and their families, focused on describing the current state of the literature and generating recommendations for future family systems work in the field of eHealth/mHealth. Twenty-three studies met inclusion criteria and were included in the systematic review. No identified studies featured an mHealth delivery modality. Relevant data were extracted and studies were assessed for quality. There was great variability with regard to intervention factors (e.g., format) and family-centered intervention targets. There is some evidence that eHealth interventions may lead to improvements in particular domains of family functioning (e.g., family conflict) for some groups of participants. However, mixed results and selection of numerous different intervention targets by investigators make it challenging to draw summative conclusions about the overall effectiveness of family systems eHealth interventions. Future research should move beyond feasibility/acceptability studies and examine family-centered processes as primary outcomes. Future research should also consider novel intervention formats to determine whether intervention effects are more robust for certain groups (e.g., individuals who prefer electronic intervention delivery to in-person intervention).

Keywords Pediatric chronic illness · eHealth · Technology · Family functioning

Introduction

Family systems interventions in pediatric chronic illness are used across pediatric populations (e.g., cancer, T1DM, TBI, asthma, obesity, and sickle cell, Eccleston, Fisher, Law, Bartlett, & Palermo, 2015; Mullins, Gillapsy, Molzon, & Chaney, 2014). These interventions are of critical importance because of the prevalence of pediatric chronic illness (e.g., Van Cleave, Gortmaker, & Perrin, 2010) and the wide-reaching impact of many pediatric illnesses on the entire family system. For example, within the field of pediatric oncology, several studies highlight the interconnectedness between family members in terms of psychosocial functioning and outcomes (Gutiérrez-Colina, Lee, VanDellen, Mertens, & Gilleland Marchak, 2017; Pai et al., 2007; Van Schoors et al., 2017). Moreover, research shows that parent, child, and family-level functioning are closely linked, and that a positive family environment supports better physical and psychosocial outcomes for children with chronic illnesses (Alderfer, Kazak, & Canter, in press). Family systems interventions include interventions for parents (e.g., Sahler et al., 2005, 2013) or multiple members of the family (e.g., Kazak, Simms, & Rourke, 2002; Palermo et al., 2009). While the advantages of family systems interventions are well documented in the field, logistical difficulties related to participant recruitment, scheduling, and retention often interfere with intervention delivery, particularly during times of acute crisis (Devine et al., 2016; Lutz Stehl et al., 2009; Tercyak, Donze, Prahlad, Mosher, & Shad, 2006).

eHealth (electronic) and mHealth (mobile) interventions may help overcome some of these challenges by offering alternative and potentially more accessible modalities of intervention delivery when compared to in-person interventions. Broadly speaking, eHealth interventions use technology (e.g., telehealth) to enhance delivery of psychosocial or medical care, and may supplement or replace in-person intervention (Cushing & Steele, 2010; Palermo, 2008).

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mHealth generally refers to the use of mobile technology, including smartphones, wearable devices, and text messaging (Borrelli & Ritterband, 2015). With regard to family systems interventions, eHealth and mHealth interventions present a unique opportunity to overcome several barriers common to in-person interventions. For example, eHealth and mHealth interventions are generally more flexible than traditional face-to-face interventions in terms of timing and location of intervention delivery, which may make it easier to recruit and retain multiple family members. A recent manuscript from Doss, Feinberg, Rothman, Roddy, and Comer (2017) highlights some of the potential advantages of using technology to deliver family interventions, including reduced barriers to care and potential engagement of multiple family members, some of whom may be unwilling to commit to an in-person intervention. Additionally, given the high estimated costs associated with several pediatric chronic illnesses (e.g., Miller, Coffield, Leroy, & Wallin, 2016) and the increased focus on cost-containment and cost-effectiveness within healthcare (McGrady, 2014; Orszag & Emanuel, 2010), eHealth interventions that increase access to and efficiency of evidence-based interventions may be appealing to insurers and healthcare systems from a financial perspective.

A recent review of the literature found that the internet is commonly used by caregivers to seek out health-related information and communicate with health professionals, as well as to build support networks (Park, Kim, & Steinhoff, 2016). Most households in the United States have access to a computer (83.8%) and/or smartphone (77%) and 74.4% have internet access (File & Camille, 2014; Pew Research Center, 2017), indicating that web-based interventions are a potentially important mechanism for overcoming barriers to face-to-face intervention services. To that end, eHealth and mHealth interventions have been utilized increasingly by psychologists for delivery of family interventions in cystic fibrosis (e.g., Stark et al., 2016), injury (Marsac et al., 2013), encopresis (e.g., Ritterband et al., 2008), chronic pain (e.g., Long & Palermo, 2009; Palermo et al., 2009), and cancer (e.g., Mayer et al., 2010).

Several meta-analytic and systematic reviews have previously been conducted regarding use of eHealth/mHealth in child psychology (Brannon & Cushing, 2015; Cushing & Steele, 2010; Fedele, Cushing, Fritz, Amaro, & Ortiga, 2017; Stinson, Wilson, Gill, Yamada, & Holt, 2009), and a recent review summarized the literature related to technology-based interventions for youth with mental/behavioral health concerns and their parents (Watson McDonell & Prinz, 2017). However, to the best of our knowledge, there has not been a prior review specifically focused upon technology-focused family interventions in pediatric chronic illness. As these interventions increase in frequency and popularity, there is an important need to summarize the existent literature and understand the potential impact of these interventions on family-centered processes (e.g., conflict, communication). This primary purpose of this review is to describe characteristics of current technology-focused interventions for families of children with chronic illnesses, including any evidence for effectiveness with regard to targeted family-centered processes. A secondary aim is to generate recommendations for future family systems work in the field of eHealth/mHealth based upon the present state of the literature.

Methods

Search Process

Procedures for this systematic review were guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) model (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009). Initial literature searches were performed in PubMed, CINAHL, and PsycInfo for all articles published from database inception through August 2016. A second search was conducted in July 2017 to capture any additional published studies. Two medical research librarians assisted with the selection of search terms and search process. No attempts were made to locate or contact researchers for unpublished studies such as dissertations or conference presentations.

Search terms included the following words: "family system," "family function," "family," "parent," "eHealth," "mHealth," "internet," "telehealth," "web-based," "pediatric," "child." A wildcard symbol (*) was used for certain terms (i.e., family function*, family system*, child*) to ensure that variations of the keywords were retrieved. Reference lists of seminal papers in the field and papers identified for inclusion through the initial literature search were also manually searched to ensure that all potentially eligible studies were identified. The search yielded 5048 peer-reviewed articles, with 3262 remaining after duplicates were removed.

Study Selection

To be eligible for inclusion in the systematic review, articles had to meet the following criteria: (1) written in English; (2) published in a peer-reviewed journal; (3) randomized control trial; (4) pediatric chronic illness focus (pediatric defined as ≤ age 21); (5) Family focused, defined as either focusing on a family systems outcome (e.g., direct impact of a pediatric health condition on a parent behavior), a family process (e.g., problem solving), or a family relationship (e.g., parent–child relationship). (6) eHealth or mHealth intervention.

Articles were excluded if they failed to meet any of the inclusion criteria. For the purpose of tracking reasons for exclusion, articles that were excluded for multiple reasons (e.g., not pediatric, not eHealth) were only tracked as excluded for the first inclusion criteria that they failed to meet. Interventions that were primarily in-person interventions (e.g., in-person intervention with two phone-based check-ins) were excluded. Although mHealth studies were eligible for inclusion, no studies that met all inclusion criteria featured mHealth interventions.

Review Process

Twenty percent of all initially identified articles were screened independently for inclusion/exclusion by three coders (K.C., J.C., and M.S.) to establish reliability. All discrepancies were reviewed and discussed until consensus was achieved. Following the establishment of reliability, remaining articles were evenly divided between the three coders and titles and abstracts were screened to determine eligibility for full-text review. The coders then conducted full-text review of eligible articles, and met again to review the process for data abstraction. Data abstracted from the articles included: sample information (e.g., population, age range), intervention information (e.g., type of eHealth, length of intervention), outcome information (e.g., target outcomes, data collection time points, measures used), and family-specific results (e.g., results related to family conflict or communication). Final eligibility for inclusion in the systematic review was established by consensus of all coders.

Study quality was assessed using the CONSORT checklist for reporting trials of non-pharmacologic treatments. All included studies ($n = 23$) were independently assessed by two study authors (K.C. and M.S.). Agreement was 93% following the first search and all discrepancies were discussed until consensus was achieved. Three additional studies were added to the review following the conclusion of the second search, and agreement was 100% for these new studies. Using a descriptive system created by Stinson et al. (2009) to group studies based on quality according to the 23-item CONSORT checklist for non-pharmacological trials, studies were rated "poor" if scored ≤ 8, "fair" if rated between 9 and 16, and "good" if rated ≥ 17. According to this system, articles were awarded one point for each item on the CONSORT checklist that was addressed by the authors. A copy of the most recent CONSORT checklist is available for download from the CONSORT statement website (http://www.consort-statement.org/extensions?ContentWidgetId=558; Boutron et al., 2017).

Results

A final search yielded 3262 unique records. Of these, 3123 were removed after an initial title/abstract screen. Full-text records ($n = 139$) were assessed for eligibility, and 116 were excluded for reasons detailed in Fig. 1 (e.g., not pediatric health focused). Twenty-three articles were included in the systematic review.

Study Quality

There was some variability with regard to study quality for the included studies. One study (4%) was rated as "poor," 7 studies (30%) were rated as "fair," and 15 (65%) studies were rated as "good." The only study rated as poor did not report anticipated results due to high attrition, so zeros were awarded for many categories in the rating system by default. It appeared that the majority of the "fair" studies and all of the "good" quality studies were reported with specific attention to include the elements of the CONSORT checklist, as they frequently reported on specific items covered by the checklist such as randomization procedures.

Characteristics of Study Participants

Detailed demographic data for each study are shown in Table 1. Interventions[1] targeted families of children with asthma, burns, cancer, chronic kidney disease, chronic pain, epilepsy, headache, obesity, type 1 diabetes, sickle cell disease, and traumatic brain injury (TBI). Interventions included a wide range of number of participants, ranging from 6 individuals to 320 individuals. Most interventions included multiple members of the family; however, 6 of the 23 interventions were delivered to only one family member (4 to caregivers only, 2 to children only). About one-third of the studies (8 out of 23) were from the same research group and focused on TBI. 17 studies provided some measure of family socioeconomic status or income, 14 studies included some measure of parent educational status, and only 4 studies provided any information about parental employment status.

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[1] Intervention conditions included the following: I-InTERACT (TBI), unnamed online program (burns), Triple P 'Positive Parenting Programme' (Asthma), telemedicine (obesity), videoconferencing (epilepsy), TeenCope (T1DM), Web-MAP (chronic pain, headache), telehealth behavioral therapy (T1DM), CAPS (TBI), OPIS (CKD), online FPS (TBI), TOPS (TBI), Cascade (cancer survivors), HIP-Teens (obesity), STARBRIGHT World (SCD).

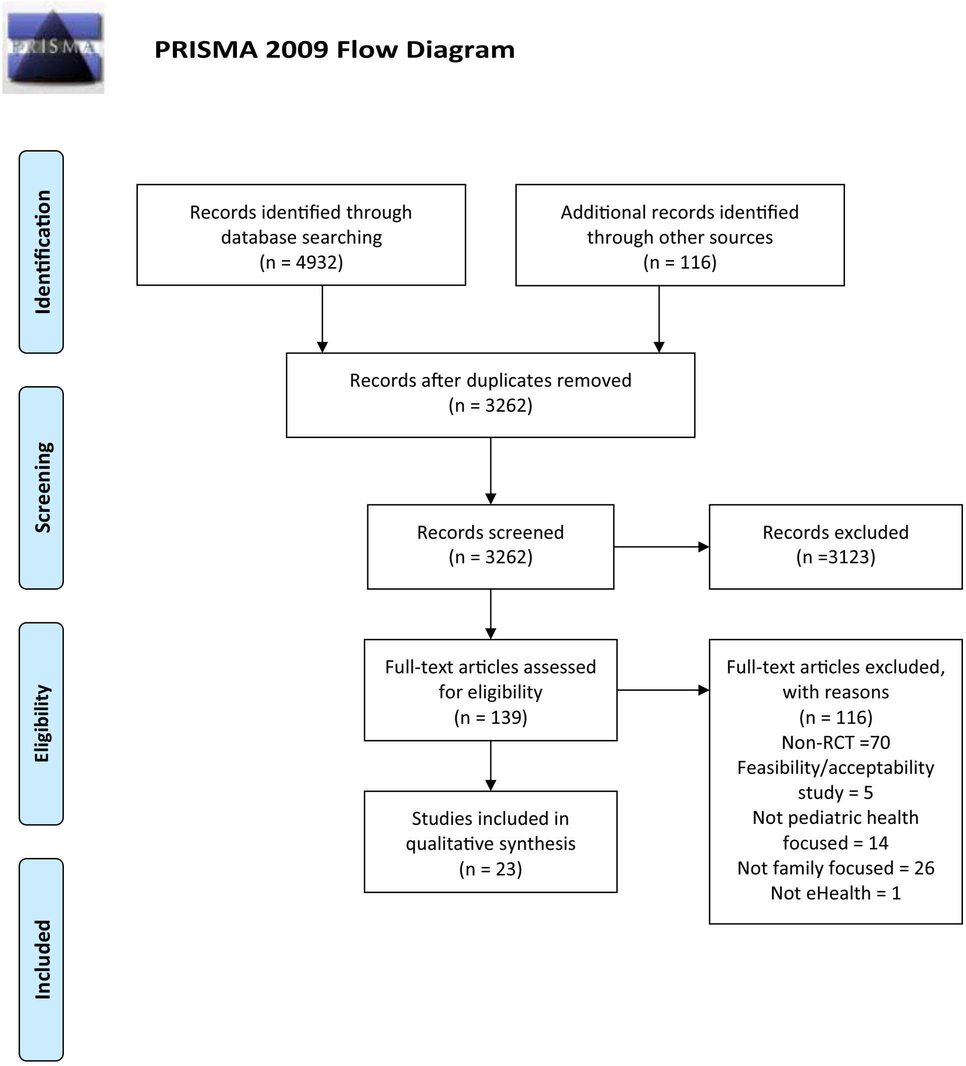

Fig. 1 PRISMA diagram for article selection. Reproduced with permission from Moher et al. (2009). http://www.prisma-statement.org

Characteristics of Interventions

Interventions varied in specific characteristics (Table 2). Control group conditions included no-treatment waitlists, usual care, specialized care, and access to information-only websites. Intervention length ranged from 3 to 36 sessions, and duration ranged from 2 weeks to 2 years[2]. 17 of the 23 interventions were delivered via multiple modalities, such as through a website with a teleconference follow-up component. 20 of the 23 interventions included some form of contact with an interventionist, ranging from online messaging with a coach to videoconferencing to review session content and learn new skills.

Family-Centered Processes

Several common categories of family-centered processes were evident across studies and are discussed below. Refer to Table 3 for detailed information about the processes measured in each study. It was rare for the family-centered process to be the sole or primary outcome. The majority of included studies investigated a range of measured outcomes, including feasibility and psychosocial outcomes (e.g., internalizing symptoms) for a specific member of the family.

Family Conflict/Problems/Communication

Eight studies (Glueckauf et al., 2002; Grey et al., 2013; Ketchen et al., 2006; Lehmkuhl et al., 2010; Narad et al., 2015; Sveen et al., 2017; Wade et al., 2011; Whittemore et al., 2012) targeted conflict/problems/communication between members of the family and assessed this as an intervention outcome, with six of the eight studies reporting a

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[2] White et al. (2004) featured a 2-year intervention; however, outcomes from the first 6 months only are reported in the included manuscript.

Table 1 Characteristics of participants

References	Pediatric sample	Caregiver sample	Intervention group	Control group
Antonini et al. (2014)	$n = 37$ children with TBI ages 3–9 years	Caregivers/legal guardians	$n = 20$ Mean age = 5.60 (2.09) 70% Male 60% Caucasian, 40% African American/Black/Multiracial	$n = 17$ Mean age = 5.24 (2.14) 65% Male 65% Caucasian, 35% African American/Black/Multiracial
Clarke, Calam, Morawska, and Sanders (2014)	$n = 13$ children with asthma ages 2–7 years Mean age = 3.65 (1.70) Male = 8, female = 5 Child ethnicity White = 10 Mixed = 2 Pakistani = 1	Caregivers	$n = 8$	$n = 5$
Davis et al. (2016)	$n = 103$ children with obesity ages 5–12 years	Caregivers	$n = 42$ Mean age = 9.39 (1.70) 40.48% Male; 92.68% Caucasian	$n = 61$ Mean age = 8.97 (1.96) 47.54% Male; 85.25% Caucasian
Davis, Sampilo, Steiger Gallagher, Landrum, and Malone (2013)	$n = 58$ children with obesity from 3rd to 5th grade	Caregivers	$n = 31$ Mean age = 8.48 (1.73) 70.97% Male; 96.77% Caucasian	$n = 27$ Mean age = 8.69 (1.78) 70.37% Male; 81.48% Caucasian
Glueckauf et al. (2002)	$n = 22$ children with epilepsy ages 12–19 years Mean age = 15.4 (2.5) 14 Males, 8 females	Caregivers $n = 36$ (21 mothers, 15 fathers) Mothers Mean age = 41.1 (5.5) Fathers Mean age = 43.5 (5.5) 100% Caucasian	$n = 9$	$n = 6$ office-based family counseling (OFC) $n = 7$ Waitlist
Grey et al. (2013)	$n = 320$ children with T1DM ages 11–14 years Mean age = 12.3 ± 1.1 years; 55% female; 62.2% non-Hispanic white, 37.8% Black/Hispanic/Other	Children only	$n = 167$	$n = 153$
Ketchen et al. (2006)	$n = 37$ children with sickle cell disease ages 8–18	Caregivers	$n = 20$ allocated to STARBRIGHT World intervention; Mean age = 12.70 (2.60) 20 Females	$n = 17$ allocated to wait-list control; Mean age = 12.18 (3.05) 16 Females, 1 male
Law, Beals-Erickson, Noel, Claar, and Palermo (2015)	$n = 83$ children with headache ages 11–17 years	Caregivers	$n = 44$ Mean age = 14.6 (1.8) 84.1% Female; 97.7% Caucasian; 2.3% Asian	$n = 39$ Mean age = 14.3 (1.6) 79.5% Female; 84.6% Caucasian, 15.4% Black/Asian/Multiracial

Table 1 (continued)

References	Pediatric sample	Caregiver sample	Intervention group	Control group
Lehmkuhl et al. (2010)	$n = 32$ children with T1DM ages 9–17 Mean age = 13.66 (2.43) 23 Female; 81.2% Caucasian, 12% African American; 6.8% Hispanic/Other	Caregivers 84.4% mothers, 9.3% grandparents/guardians, 6.3% fathers; Mean age = 41.53 (8.14)	$n = 18$	$n = 14$
Narad et al. (2015)	$n = 132$ children with TBI ages 11–14	Caregivers 86% mothers, 10% fathers, 4% grandparents/other	$n = 65$ Mean age = 14.68 (1.68) 20% non-white; 44% Male	$n = 67$ Mean age = 14.98 (1.78) 19% non-white; 42% Male
Palermo et al. (2009)	$n = 48$ children with chronic pain ages 11–17	Caregivers	$n = 26$ Mean age 14.3 (2.1) 76.9% Female; 80.8% Caucasian; 19.2% Hispanic/Other	$n = 22$ Mean age 15.3 (1.8) 68.2% Female; 22% Caucasian
Palermo et al. (2016)	$n = 273$ children with chronic pain ages 11–17 years	Caregivers	$n = 138$ Child demographics: Mean age = 14.63 (1.62) 78.3% Female; 92% Caucasian, 8% African American/Hispanic/Other; Caregiver demographics: 92.8% Female; 93.5% Caucasian	$n = 135$ Child demographics: Mean age = 14.70 (1.72) 71.9% Female; 77.8% Caucasian, 22.2% African American/Hispanic/Other; Caregiver demographics: 95.6% Female; 80.7% Caucasian
Petranovich et al. (2015)	$n = 132$ children with TBI ages 12–17 years	Caregivers	$n = 65$ Child demographics: Mean age = 14.70 (1.67) 67.6% Male; 80.8% Caucasian, 10.7% African American, 9.3% Multiracial; Caregiver demographics: Mean age = 41.90 (7.34); 92.3% Female; 84.6% Caucasian, 10.7% African American; 4.6% Multiracial	$n = 67$ Child demographics: Mean age = 14.99 (1.76); 62.6% Male; 80.6% Caucasian, 16.4% African American, 2.9% Multiracial; Caregiver demographics: 88% Female 83.5% Caucasian, 16.4% African American

Table 1 (continued)

References	Pediatric sample	Caregiver sample	Intervention group	Control group
Raj et al. (2015)	$n = 37$ children with TBI ages 3–9 years	Caregivers	$n = 20$ Child demographics: Mean age = 5.60 (2.09); 70% Male; 60% Caucasian; Caregiver demographics: Mean age = 32.80 (7.36)	$n = 17$ Child demographics: Mean age = 5.24 (2.14); 65% Male; 65% Caucasian; Caregiver demographics: Mean age = 32.50 (7.38)
Sveen, Andersson, Buhrman, Sjöberg, and Willebrand (2017)	$n = 62$ caregivers of children with burns < 18 years old	Caregivers only	$n = 31$ 22 Mothers, 9 fathers Mean caregiver age = 36.4 (6.6)	$n = 31$ 20 Mothers, 11 fathers Mean caregiver age = 38.3 (5.5)
Swallow et al. (2014)	$n = 55$ caregivers of children with chronic kidney disease ages 0–19	Caregivers only	$n = 26$ Child demographics: Mean age = 10.2 (5.7); 69% Male; Caregiver demographics: Mean age = 44.1 (8.3); 50% Male; 73% Caucasian, 27% South Asian	$n = 29$ Child demographics: Mean age = 9.1 (5.5); 71% Male; Caregiver demographics: Mean age = 42.7 (10.3); 42% Male; 84% Caucasian, 5% Afro-Caribbean, 11% South Asian
Wade, Carey, and Wolfe (2006)	$n = 46$ children with TBI ages 5–16 years	Primary caregivers and children; secondary caregiver and school-aged siblings encouraged to participate	$n = 26$ Child mean age = 10.92 (2.45) 80% Caucasian; 20% African American	$n = 20$ Child mean age = 11.00 (3.93); 70% Caucasian; 30% African American
Wade et al. (2014)	$n = 132$ children ages 12–17 years with TBI	Primary caregivers and children; secondary caregiver and school-aged siblings encouraged to participate	$n = 65$ Child mean age = 14.40 (1.68) 20% Non-White	$n = 67$ Child mean age = 14.67 (1.77); 19% Non-White
Wade et al. (2011)	$n = 41$ children with TBI ages 11–18 years	Primary caregivers and children; secondary caregiver and school-aged siblings encouraged to participate	$n = 20$ Child mean age = 14.02 (2.45) 38% Male; 94% Caucasian	$n = 21$ Child mean age = 14.49 (2.13); 58% Male; 89% Caucasian
Wade et al. (2012)	Same as Wade et al. (2011)			
Wakefield et al. (2016)	$n = 47$ caregivers of childhood cancer survivors	Caregivers only	$n = 22$ Child demographics: Mean age = 8.48 (3.83); 43.5% Male; Caregiver demographics: Mean age = 42 (5.76); 8.7% Male	$n = 22$ Child demographics: Mean age = 8.18 (3.84); 68.2% Male; Caregiver demographics: Mean age = 42.77 (5.21); 18.2% Male

Table 1 (continued)

References	Pediatric sample	Caregiver sample	Intervention group	Control group
White et al. (2004)	$n = 57$ children with overweight status (BMI 85th percentile) ages 11–15 years	Caregiver with obesity	$n = 28$ Child demographics: Mean age = 13.14 (1.59); Caregiver demographics: Mean age = 43.53 (6.24)	$n = 29$ Child demographics: Mean age = 13.23 (1.16); Caregiver demographics: Mean age = 42.87 (6.18)
Whittemore et al. (2012)	$n = 320$ children with T1DM ages 11–14 years; Mean age = 12.3 ± 1.1 years	Children only	$n = 167$ 44.3% Male; 64.5% Caucasian, 18.1% Hispanic, 8.4% Black, 7.2% Multiracial; 1.8% Other	$n = 153$ 45.1% Male; 61.2% Caucasian, 22.4% Hispanic, 7.2% Black, 7.9% Multiracial; 1.3% Other

significant reduction in some form of conflict following the intervention for at least some participants. Whittemore et al. (2012) also reported a reduction in conflict for all participants, although this reduction was not significant. Several studies also reported significant results in the opposite direction than was predicted. Lehmkuhl et al. (2010) found that parents in the treatment arm reported a significant increase in unsupportive behaviors and youth in the treatment arm reported a significant decrease in warmth and caring parenting behaviors, while parents and youth in the waitlist group reported the opposite effects. Narad et al. (2015) reported mixed effectiveness with regard to parent–child conflict, but also found significant declines in observed effective parent–child communication for participants with severe TBI in the intervention group. Conflict was measured differently across studies, ranging from illness-specific measures of family conflict (Grey et al., 2013) to single items about perceived relationships between family members (Wade et al., 2011). Although it is difficult to draw summative conclusions due to different definitions and measurement of conflict/problems, results from included studies suggest that eHealth interventions are generally effective with regard to decreasing family conflict.

Protective Parenting Behaviors

Three studies (Law et al., 2015; Palermo et al., 2009, 2016) focused on chronic pain and headache with a goal of reducing protective parenting behaviors. One study by Palermo et al. (2016) reported a greater decline in protective behaviors and miscarried helping for the intervention group when compared to the internet education only group; the two remaining studies (Law et al., 2015; Palermo et al., 2009) found declines in both the intervention group and the control group. This may suggest that eHealth interventions are as effective, but not more effective, than other treatment options (e.g., specialized in-person care) for changing parent behavior related to pediatric chronic pain.

Caregiver Self-Efficacy

Caregiver self-efficacy was an intervention target in three studies from two research groups (Petranovich et al., 2015; Swallow et al., 2014; Wade et al., 2014). All studies found improvement in measures of self-efficacy for perceived self-efficacy and competence in management of their child's condition, although self-efficacy was defined and measured differently by all investigators. One group (Petranovich et al., 2015) concluded that their results likely suggested preexisting differences between parents in the intervention and control group rather than an effect of the intervention, and another study from this same research group (Wade et al., 2014) found a significant effect only for parents who

Table 2 Characteristics of included studies

References	Family members included	Intervention (*N*)	Control group (*N*)	Type of intervention	Length of intervention	Intervention (how it was delivered, who delivered it)	Study quality
Antonini et al. (2014)	Caregivers/legal guardians and children	20 allocated to I-InTERACT (Internet-based interacting together every day: recovery after childhood TBI)	20 allocated to internet resources comparison	Multiple modalities: self-guided web session and videoconference with therapists	10 core sessions (1 in person) with 4 supplementary sessions; average time of completion is 8.16 months	Web session was self-guided with videos and exercises; 3 masters-level therapists provided videoconferencing to review session, role play new skills and get feedback	Good
Clarke et al. (2014)	Caregivers only (13 mothers)	8 allocated to Triple P 'Positive Parenting Programme'	5 allocated to control group	Website with group seminar series and video clips	8 weeks	Self-directed intervention	Poor
Davis et al. (2016)	Caregivers and children	42 allocated to telemedicine intervention	61 allocated to phone intervention	Multiple modalities: telephone or telemedicine (video) group; in person child group	14 total sessions, 8 weekly meetings, then 6 monthly meetings	Clinician member of the research team and on-site school representative met with the children during the parent group	Fair
Davis et al. (2013)	Caregivers and children	31 allocated to telemedicine intervention	27 allocated to physician visit intervention	Multiple modalities: in person parent group; in-person child group; telemedicine	14 total sessions, 8 weekly meetings, then 6 monthly meetings, some individual phone sessions	PhD level psychologist or trained graduate students/postdoctoral fellows	Good
Glueckauf et al. (2002)	Caregivers and children	9 allocated to videoconferencing-based family counseling (VFC)—4 received speakerphone family counseling (SFC)	6 allocated to office-based family counseling (OFC); 7 families allocated to Waitlist	Multiple modalities: videoconferencing, speakerphone family counseling, office-based family counseling	6 sessions once every 2 weeks	Counselors provided the interventions through the various modalities	Fair
Grey et al. (2013)		167 allocated to TeenCope (Internet Coping Skills Training program)	153 allocated to Managing Diabetes (Internet diabetes health education program)	Multiple modalities: graphic novel video format; discussion board; website	5 sessions (1/week)	Interventions were provided through graphic novel video format, monitored discussion board (TeenCope) and a diabetes education and problem-solving program via a website (Managing Diabetes)	Fair

Table 2 (continued)

References	Family members included	Intervention (*N*)	Control group (*N*)	Type of intervention	Length of intervention	Intervention (how it was delivered, who delivered it)	Study quality
Ketchen et al. (2006)	Caregivers and children	20 allocated to STARBRIGHT World intervention	17 allocated to wait-list control	Multiple modalities: CD-ROM and internet intervention, paper booklet	6 sessions completed weekly	Self-guided after installation of computer program by research team	Fair
Law et al. (2015)	Caregivers and children	44 allocated to Internet CBT (Web-based Management of Adolescent Pain; Web-MAP) + specialized headache treatment	39 allocated to specialized headache treatment	Multiple modalities: website with interactive messaging	Approximately 9 h per family (4/adolescent, 4/parents and 1-h online coach time)	Intervention provided via website; Online coach (PhD level postdoctoral fellow) provided feedback	Good
Lehmkuhl et al. (2010)	Caregivers	18 allocated to Telehealth Behavior Therapy (TBT)	14 allocated to waitlist	Telemedicine	36 sessions (15–20 min) over 12 weeks	Pre-doctoral clinical psychology interns conducted intervention over the phone	Fair
Narad et al. (2015)	Caregivers	65 in Counselor Assisted Problem Solving (CAPS) program	67 in Internet Resource Comparison Group	Multiple modalities: website and teleconferencing with one in-person session	6 months (7 sessions with up to 4 additional supplemental sessions)	Intervention delivered via website and by clinical psychologists via telehealth	Good
Palermo et al. (2009)	Caregivers and children	26 allocated to Internet treatment (Web-MAP)	22 allocated to wait-list control	Multiple modalities: website with interactive messaging	8-week period; 9 h per family (4-h-long child modules, 4-h-long parent modules, and 1-h therapist time)	Intervention delivered via website & an online coach (PhD level postdoctoral fellow) provided answers/responses to assignments	Good
Palermo et al. (2016)	Caregivers and children	138 allocated to Internet CBT	135 allocated to education group	Multiple modalities: website with interactive messaging	8–10 weeks, estimated 9 h per family	Intervention delivered via website & an online coach (PhD level postdoctoral fellow or master's level clinician) provided answers/responses to assignments	Good
Petranovich et al. (2015)	Caregivers and children	65 allocated to Counselor-Assisted Problem Solving (CAPS)	67 allocated to Internet resource comparison	Multiple modalities: website and teleconferencing with one in-person session	6 months (7 sessions with up to 4 additional supplemental sessions)	Intervention delivered via website and by clinical psychologists via telehealth	Good

Table 2 (continued)

References	Family members included	Intervention (*N*)	Control group (*N*)	Type of intervention	Length of intervention	Intervention (how it was delivered, who delivered it)	Study quality
Raj et al. (2015)	Caregivers and children	20 allocated to I-InTERACT program	17 allocated to Internet Resource comparison	Multiple modalities: in person session, website, skype sessions	4–6 months intervention	Intervention was delivered via the I-InTERACT website and sessions were conducted by 3 Master's level psychologists	Fair
Sveen et al. (2017)	Caregivers only	31 allocated to intervention	31 allocated to wait-list control	Multiple modalities: website with written feedback from interventionist	6 modules, 1 per week	Intervention delivered via self-guided website, with written feedback on weekly assignments from therapist	Good
Swallow et al. (2014)	Caregivers only	26 in the intervention group	29 in the control group	Website	20-week intervention	Intervention self-directed via computer	Good
Wade et al. (2006)	Caregivers and children; school-aged siblings invited to attend	26 in the intervention group	20 in the control group	Multiple modalities: website and teleconferencing with one in-person assessment	2–4 weeks	Intervention delivered via website and by clinical psychology doctoral student via telehealth	Good
Wade et al. (2014)	Primary caregivers and children; secondary caregiver and school-aged siblings invited to attend	65 in Counselor Assisted Problem Solving (CAPS) program	67 in Internet Resource Comparison Group	Multiple modalities: website and teleconferencing with one in-person session	6 months (7 sessions with up to 4 additional supplemental sessions)	Intervention delivered via website and by clinical psychologists via telehealth	Good
Wade et al. (2011)	Primary caregivers and children; secondary caregiver and school-aged siblings encouraged to participate	20 in Teen Online Problem Solving (TOPS) group	21 in Internet Resource Comparison Group	Multiple modalities: website and teleconferencing	6 months (10 sessions with up to 4 additional supplemental sessions)	Intervention delivered via website and by clinical psychologist or clinical psychology doctoral students via telehealth	Good
Wade et al. (2012)	Primary caregivers and children; secondary caregiver and school-aged siblings encouraged to participate	20 in Teen Online Problem Solving (TOPS) group	21 in Internet Resource Comparison Group	Multiple modalities: website and teleconferencing	6 months (10 sessions with up to 4 additional supplemental sessions)	Intervention delivered via website and by clinical psychologist or clinical psychology doctoral students via telehealth	Good
Wakefield et al. (2016)	Caregivers only	22 allocated to Cascade program	22 allocated to 6-month waitlist	Telemedicine	3 weekly sessions (120 min each)	Intervention delivered by psychologists via a WebEx video conference	Good

Table 2 (continued)

References	Family members included	Intervention (*N*)	Control group (*N*)	Type of intervention	Length of intervention	Intervention (how it was delivered, who delivered it)	Study quality
White et al. (2004)	Caregiver with obesity and child	28 allocated to experimental group	29 allocated to control group	Website	2-year program	Intervention self-directed via computer	Fair
Whittemore et al. (2012)	Children only	167 allocated to intervention group	153 allocated to control group	Website	5 weekly sessions	Intervention self-directed via computer	Good

were non-frequent computer users. Mixed results, such as improvements for very specific subgroups of users, do not make a strong argument for the general effectiveness of eHealth interventions on caregiver self-efficacy. However, there is some evidence that self-efficacy can be improved for certain subgroups of caregivers.

Other Family-Specific Outcomes

Other outcomes included observed parenting behaviors (Antonini et al., 2014), mealtime behavior (Davis et al., 2013, 2016), problem-solving skills (Narad et al., 2015; Wade et al., 2006, 2012; Wakefield et al., 2016), parenting stress (Sveen et al., 2017), overall family functioning (Wakefield et al., 2016), family life satisfaction (White et al., 2004), general parent–child relationship (Ketchen et al., 2006), and collaboration with parents (Whittemore et al., 2012). Results were mixed with regard to effectiveness; however, due to great variability among the processes selected by authors, specific results are described in Table 2. Only two studies focused on a disease-specific outcome. Results were not reported for asthma parenting behaviors (Clarke et al., 2014) because of high study attrition, and a significant reduction for certain domains within parent pain-related impact was reported by Palermo et al. (2016).

Discussion

The current systematic review sought to synthesize the eHealth/mHealth literature with a specific focus on family-centered processes. Family-centered care has long been recognized in the literature as an important component of optimal psychosocial care for children with a chronic illness, as the impact of childhood chronic illness extends beyond the affected child and often presents as a major stressor requiring a number of systemic changes with wide-reaching implications for all members of a family system. For the purposes of this systematic review, we use the term "family-centered" to describe a specific focus on a family process or relationship. Although eHealth and mHealth studies were eligible for inclusion, no studies utilized an app-only (mHealth) delivery modality.

Family-centered processes were not the primary measured outcome for many included studies; in fact, many studies aimed to establish feasibility/acceptability of a novel intervention design, measuring psychosocial outcomes (including family variables) as secondary outcomes. Results highlighted the broad range of work being done in this area; given the variability, it proved difficult to draw conclusions about the "best" intervention format or mode of delivery for family-centered eHealth interventions. For example, some included studies used a self-directed format with no

Table 3 Family-specific results for included studies

Study	Family-specific outcomes	How family-specific outcomes measured and data collection time points	Statistically significant family-specific results
Antonini et al. (2014)	Parent–child interactions	Direct observation coding Parent-report of child behaviors Baseline Post-treatment assessment (average time baseline to completion of 8.16 months)	Positive parenting behaviors (combined labeled praise and reflections): parents in both intervention groups (higher- and lower-income) more likely to provide positive statements post-intervention than parents in matched control groups (higher- and lower-income) ($p < .0001$) Undesirable parenting behaviors (commands, criticisms): parents in intervention and control group less likely to provide undesirable statements post-intervention ($p = .0002$) Questions: parents in intervention group less likely to ask questions post-intervention than parents in control group ($p = .03$) Child compliance after indirect commands: children in intervention and control group more compliant post-intervention ($p = .017$) Parent praise after compliance: parents in intervention group had a higher percentage of post-intervention labeled praise following compliance than parents in control group ($p < .009$) Relationship between number of sessions completed and parenting behavior: number of sessions positively associated with total number of labeled praise given during child-directed play ($p = .05$), proportion of labeled praise after compliance with an indirect command ($p = .05$), and negatively associated with number of questions during child-directed play ($p = .02$) for parents in intervention group
Clarke et al. (2014)	Asthma parenting behaviors	Parent-report of child behaviors Parent self-report	Results not reported[a]
Davis et al. (2013)	Mealtime behavior problems and management strategies	Parent-report of child Parent self-report Baseline Post-treatment	Results not significant
Davis et al. (2016)	Mealtime behavior problems and management strategies	Child self-report parent-report of child Parent self-report Baseline Post-treatment	Results not significant
Glueckauf et al. (2002)	Severity, frequency, and improvement of self-identified family problems	Parent self-report Child self-report Baseline Post-fourth session (select measures) Post-treatment 6-month follow-up	Problem severity: reduction for three intervention groups from baseline to post-treatment ($p < .001$, $\eta^2 = .75$) and baseline to 6-month follow-up ($p < .001$, $\eta^2 = .83$) Problem frequency: reduction for three intervention groups from baseline to post-treatment ($p = .02$, $\eta^2 = .25$) and baseline to 6-month follow-up ($p = < .001$, $\eta^2 = .73$) Differences by reporter: child-report of severity lower than parent-report across modalities and times ($p = .02$, $\eta^2 = .27$)

Table 3 (continued)

Study	Family-specific outcomes	How family-specific outcomes measured and data collection time points	Statistically significant family-specific results
Grey et al. (2013)	Family conflict	Child self-report Baseline 3-month follow-up 6-month follow-up 12-month follow-up 18-month follow-up	Family conflict: teenagers in Managing Diabetes group had less diabetes family conflict ($p = .02$) than those in TeenCope group at 12-month follow-up. Teenagers who completed both programs reported improved diabetes family conflict compared to teenagers who only participated in one program ($p = .04$)
Ketchen et al. (2006)	Parent–child relationship	Child self-report Parent self-report Baseline Post-treatment	Parent–child relationship: significant group × time interaction ($p < .05$), such that caregivers in the intervention group reported greater improvements in the quality of the parent–child relationship than did caregivers in the control
Law et al. (2015)	Parent response to pain behavior	Parent self-report Baseline Post-treatment 3-month follow-up	Parent protective behaviors: reduction from baseline to post-treatment and baseline to 3-month follow-up for participants in both groups ($p = .02$)
Lehmkuhl et al. (2010)	Family discord	Parent self-report Baseline Post-treatment	Unsupportive parental behavior: parent-report increased in intervention group and decreased in waitlist group ($p = .05$) baseline to post-treatment Parental warmth/caring: decreased in intervention group and increased in waitlist group from baseline to post-treatment ($p = .03$)
Narad et al. (2015)	Parent–child conflict Effective parent–child communication Family problem solving	Parent self-report Child self-report Direct observation Baseline 6-month follow-up 12-month follow-up 18-month follow-up	Parent–child conflict: significant time × treatment × TBI severity interaction by parent-report ($p = .04$, $d = .18–.23$), with different patterns for severe and moderate TBI group. For teens with severe TBI in intervention group, conflict lower at 18-month follow-up when compared to baseline and 12-month follow-up; for teens with moderate TBI in intervention group, conflict lower at 6-month follow-up when compared to baseline. Main effect for time by child-report ($p = .005$), with children reporting less conflict at 18-month follow-up compared to baseline and 6-month follow-up Effective parent–child communication: main effect of time for observed parental effective communication for all children. Significant treatment × time × TBI severity interaction for teen communication ($p = .03$), such that children with severe TBI in both groups demonstrated declines in effective communication at 6-month follow-up ($p < .01$), but change maintained in intervention group only at 12-month follow-up ($p < .01$). No significant decline in intervention group for children with moderate TBI Family problem solving: main effect of time ($p = .03$) for all participants from baseline to 6-month follow-up, with return to baseline at 12-month and 18-month follow-up

Table 3 (continued)

Study	Family-specific outcomes	How family-specific outcomes measured and data collection time points	Statistically significant family-specific results
Palermo et al. (2009)	Parent response to pain behavior	Parent self-report Baseline Post-intervention 3-month follow-up	Parent Protective Behaviors: Reductions across three time points for both intervention and control group by parent-report ($p = < .01$, partial $\eta^2 = .54$) and child-report ($p = .05$, partial $\eta^2 = .19$)
Palermo et al. (2016)	Parent response to pain behavior Miscarried helping Parent pain-related impact	Child self-report Parent Self-Report Baseline Post-treatment 6-month follow-up	Miscarried helping: greater reduction for intervention group compared to control group baseline to post-treatment ($p = < .01$, $d = -.30$) and baseline to 6-month follow-up ($p < .01$, $d = -.26$) per child-report Protective behaviors: greater reduction for intervention group compared to control group from baseline to post-treatment ($p < .001$, $d = -.49$) and baseline to 6-month follow-up ($p = .001$, $d = -.40$) Parent pain-related impact: greater reduction for parents in intervention group compared to control group for anxiety symptoms baseline to 6-month follow-up ($p = .02$, $d = -.39$), depressive symptoms baseline to post-treatment ($p = .05$, $\mathrm{d} = -.27$) and baseline to 6-month follow-up ($p < .01$, $d = .44$), and self-blame from baseline to post-treatment ($p = .03$, $d = .31$) and baseline to 6-month follow-up ($p < .01$, $\mathrm{d} = -.34$)
Petranovich et al. (2015)	Parent self-efficacy	Parent self-report Baseline 6-month follow-up 12-month follow-up 18-month follow-up	Parent self-efficacy: intervention group scored higher than control group ($p = .02$); however, the absence of treatment × time interaction suggests preexisting difference rather than treatment effect
Raj et al. (2015)	Parent self-efficacy	Parent self-report Baseline 6-month follow-up	Results not significant
Sveen et al. (2017)	Parenting stress Family conflict	Parent report Baseline Post-treatment 3-month follow-up 12-month follow-up	Results not significant

Table 3 (continued)

Study	Family-specific outcomes	How family-specific outcomes measured and data collection time points	Statistically significant family-specific results
Swallow et al. (2014)	Parent management ability Parent perception of competence Parent empowerment Father support for managing illness	Parent self-report Baseline 20-week follow-up	Parent management ability: parents in intervention group perceived more difficulties with family life due to child's condition than parents in control group ($r^2 = .94$) and perceived better parent mutuality ($\mathrm{r}^2 = .41$) than parents in control group Perception of competence: parents in intervention group perceived themselves to be managing condition better than parents in the control group ($r^2 = .82$) Father support for managing illness: fathers in intervention group had higher levels of perceived helpfulness than fathers in control group ($r^2 = .21$)
Wade et al. (2006)	Parent problem-solving skills	Parent self-report Baseline Post-treatment	Results not significant
Wade et al. (2014)	Parent self-efficacy	Parent self-report Baseline 6-month follow-up	Parent self-efficacy: among non-frequent computer users, parents in intervention group reported significantly higher levels of caregiver efficacy at 6-month follow-up than parents in control group ($p = .01$, $d = .51$)
Wade et al. (2011)	Family conflict	Parent self-report Child self-report Baseline ~ 7-month follow-up	Family conflict: parents in the intervention group reported lower levels of parent–teen conflict at follow-up than parents in the control group after controlling for pre-treatment levels of conflict ($p < .01$)
Wade et al. (2012)	Problem-solving skills	Parent self-report Child self-report Baseline ~ 7-month follow-up	Problem-solving skills: parents in lower-income intervention group reported improvements in rational problem solving from baseline to follow-up ($p < .05$), parents in lower-income intervention group and higher-income control group reported improvement in positive problem orientation from baseline to follow-up ($p < .05$)
Wakefield et al. (2016)	Family problem solving, communication, and general functioning	Parent self-report Baseline 2-week follow-up 6-month follow-up	Results not significant
White et al. (2004)	Family life satisfaction Satisfaction with life	Parent self-report Child self-report Baseline 6-month follow-up Weekly quizzes	Family life satisfaction: parent satisfaction with life related to DXA change ($p < .05$), effects of experimental condition on change in DXA no longer significant after controlling for parent satisfaction with life and parent family satisfaction
Whittemore et al. (2012)	Family conflict Collaboration with parents	Child self-report Baseline 3-month follow-up 6-month follow-up	Collaboration with parents: children in intervention and attention control group showed decrease in collaboration with parents over time ($p < .05$)

[a] Data collection intended for pre-treatment and post-treatment, no post-treatment data reported due to high attrition

live interventionist, while other interventions were delivered entirely via telehealth. The overwhelming majority of studies featured some type of hybrid design, with only three studies relying on a "pure" internet delivery modality. This highlights the wide range of formats that are captured under the eHealth umbrella and may be logical given the relative newness of this line of research. However, this variability with regard to design and methods also presents unique challenges when attempting to summarize the literature and draw conclusions about overall effectiveness, which was a primary aim at the outset of this study. Future researchers might consider using standardized intervention formats or delivery modalities in order to allow for easier comparisons between interventions and the ability to more readily evaluate effectiveness for a certain type of eHealth intervention. Careful attention to the CONSORT checklist may also help ensure that published literature in this field is high quality, which will be helpful for future researchers hoping to draw conclusions about the literature.

The majority of interventions measured family processes as one of the many outcomes (e.g., internalizing symptoms), and often were directed to a specific family member (e.g., skills for parents). In the future, researchers and clinicians may want to explore options for including multiple members of the family at one time, as this more closely mirrors traditional family therapy and may lead to more robust results regarding family systems variables. For example, the ability to include multiple members of the family from different locations in an intervention via eHealth may lead to improvements in family cohesion or decreases in family conflict. This is particularly important given the interconnectedness between members of a family system, and the impact that one member's psychosocial functioning can have on other members of the family (e.g., the impact of parental depression on child functioning). Engagement of multiple family members may also be higher for eHealth interventions, as individuals who are unwilling to attend in-person mental health sessions due to stigma may also be more willing to engage in eHealth interventions (Doss et al., 2017). Additionally, future work should move beyond feasibility/acceptability and focus on family processes and outcomes as primary intervention targets in order to better understand the potential impact of these novel interventions.

Additionally, while many of the included studies reported a positive effect on targeted family-centered processes, this positive effect was not always stronger or different than the effect reported by participants in the control group. Control group conditions also varied greatly among included studies, ranging from no-treatment waitlists to provision of highly specialized in-person care. Further complicating matters is the fact that many study teams found positive intervention effects for one component of family functioning while finding non-significant or negative results for other family-focused outcomes. This is consistent, to some extent, with previous literature related to family functioning in the context of childhood illness. For example, Eccleston et al. (2015) found some evidence for the effectiveness of family problem-solving therapy on parent adaptive behavior, but limited overall evidence for the ability of psychological intervention to impact parental behavior or mental health.

Similar to findings reported by Stinson et al. (2009), most studies also included some form of contact with an interventionist. With an interventionist component, even if the role is greatly reduced, some of the challenges with in-person interventions likely still exist (e.g., scheduling based on family and clinician availability). This was apparent in several of the included studies where high attrition or recruitment challenges occurred, even preventing data analysis for one study team (i.e., Clarke et al., 2014). There is some suggestion in the family systems literature that the presence of an interventionist/coach positively impacts intervention retention and outcomes (Roddy, Nowlan, & Doss, 2017), although this remains an understudied area within pediatric psychology and eHealth. If eHealth interventions are not, in fact, improving accessibility to family-centered psychosocial care, this lends further support to the need to investigate other advantages of this intervention modality (e.g., cost effectiveness) and is also a call to action to work harder to eliminate barriers to accessibility.

The overwhelming inclusion of interventionist contact could also potentially speak to a broader discomfort in the field with removing all of the human interaction from a therapeutic intervention. While this hesitation is not inherently negative, it will be important for future studies to compare "pure" eHealth interventions with no interventionist to interventions with some "live" component in order to begin to understand the potential role of interventionists in eHealth intervention delivery. This type of comparison will lead to a deeper understanding of the potential impact of intervention design on important psychosocial outcomes. By better understanding the potential role of the interventionist as a potential "active ingredient" in effective eHealth interventions, future researchers will be able to develop interventions with maximal impact on family functioning and clinical care.

In addition to future work identifying the core components of effective eHealth interventions, future researchers should consider including additional outcomes, such as cost effectiveness, which may make a strong case for eHealth intervention delivery even if family-level outcomes do not differ significantly from those reported in effective in-person interventions. With the identification of "active ingredients" and a clearer understanding of factors that predict success in eHealth interventions, novel intervention designs such as SMART trials may provide a structured model for using decision points to triage families into eHealth vs. in-person interventions (Collins, Collins, Murphy, & Strecher, 2007; Noser, Cushing, McGrady, Amaro, & Huffhines, 2017). Another potential area for future research is person preference studies, where participants would select whether they would like to receive an in-person or eHealth/mHealth intervention. This would help to determine whether these interventions are effective for individuals who select this modality and, in theory, might not otherwise receive a desired or necessary service. eHealth/in-person "hybrid" designs, where technology might be utilized to include family members who are geographically or otherwise unable to participate in person, present another interesting possibility for future research. By actively increasing the flexibility of eHealth/mHealth interventions, as opposed to assuming that they are inherently more flexible by nature of relying on technology, the impact on family-centered processes might become more robust.

Like all studies, this systematic review should be considered in the context of its limitations. Given the variability among selected target outcomes and measurement of these outcomes, this review is primarily descriptive and does not include a meta-analytic component. Unpublished studies were not included, which raises concern for publication bias. In addition to potential non-publication of null findings, it is possible that new and exciting work that could change conclusions exists but has not yet been published (e.g., doctoral dissertations). This review was also limited to studies with a chronic-illness focus; family-centered studies with broader focuses (e.g., health promotion or prevention programs in the general population) may also provide important guidance for future work in pediatric psychology.

The current study provides a synthesis of the literature related to family systems eHealth interventions for children with chronic illnesses and their families. While many of the included studies reported encouraging results in at least one target outcome, there was great variability between studies with regard to selected outcomes and robustness of findings. As society continues to move rapidly towards greater reliance on technology in all areas, it will be important for the field of family psychology to gain a better understanding of the processes underlying the development of successful eHealth interventions to ensure the design and deployment of effective and efficacious family systems interventions.

Acknowledgements The authors would like to thank Melissa Alderfer, Ph.D., for her helpful comments on an earlier draft of this manuscript. The PRISMA Statement and the PRISMA Explanation and Elaboration document are distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Compliance with Ethical Standards

Conflict of interest Kimberly S. Canter, Jennifer Christofferson, Michele A. Scialla, and Anne E. Kazak declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human participants or animals performed by any of the authors.

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