



Technology-Based Peer Support Interventions for Adolescents with Chronic Illness: A Systematic Review

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Abstract

Technology may help adolescents with chronic illnesses overcome barriers to accessing peer support, which has been associated with better quality of life and health outcomes. This review aimed to describe technology-based peer support interventions for adolescents with chronic illness following Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Of 3781 articles identified, 32 met inclusion criteria. The most common technologies were websites with discussion forums ($n=18$), chat messaging ($n=9$), and video conferencing ($n=7$). Most studies (69%) focused on feasibility and had small sample sizes. Results support the feasibility and acceptability of these interventions. Results suggested positive effects on social support, but were mixed on isolation, quality of life, and disease self-management. There were too few adequately powered randomized controlled trials to determine efficacy of these interventions at this time. Future work should use rigorous methods to evaluate efficacy and account for rapid shifts in technology for adolescent communication.

Keywords Adolescents · Peer support · Technology · Telehealth · Chronic illness

Introduction

The period of adolescence is marked by profound physical and mental growth and is recognized as formative years for identity development (Stangor & Walinga, 2010). As part of normal growth, adolescents develop independence from parents and form strong peer attachments as they develop autonomy (Christie & Viner, 2005). The World Health Organization has estimated that up to 15% of adolescents worldwide may have a chronic illness, and reported that for these teens, treatment regimens and disabilities related to chronic illness can impact the socialization process for adolescents (Michaud et al., 2007). Peer-to-peer support, which connects people with the same illness, has been shown to

both improve disease management and quality of life outcomes among adults with chronic illnesses, as well as reach groups that other healthcare services fail to engage, such as those from low socioeconomic backgrounds, rural communities, and racial/ethnic minorities (Bennett et al., 2018; Dennis, 2003; Fisher et al., 2012; Sokol & Fisher, 2016; Warshaw et al., 2019). Peer mentoring and support can be highly useful to teens with chronic illness and can improve their social connectedness, disease self-management, adherence, and quality of life (Ahola Kohut et al., 2014; Merianos et al., 2015).

Although peer support can be helpful, individuals may face geographic or logistical obstacles in obtaining peer support from others with the same illness. Particularly in the context of the global pandemic, where many patient visits were converted to telehealth and previously established support groups and other meetings were either put on hold or converted to a virtual format, the use of technology to connect with peers may overcome many of these obstacles. Indeed, in recent nationwide surveys, 95% of teens report access to a smartphone or home computer, with 45% of teens reporting being on the Internet “almost constantly” (Anderson & Jiang, 2018). A systematic review showed that adults with chronic illness use online communities to rebuild their social networks and share knowledge (Kingod et al., 2016).

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A prior systematic review of peer support interventions for adolescents with chronic illness found that only three of eleven studies featured technology-based communication despite the prevalence of technology use by teens (Ahola Kohut et al., 2014).

Technology has rapidly become a form of communication and connection for adolescents since the last published review of peer support interventions. In particular, adolescents almost universally use social media for a variety of reasons, including to seek health information and disease-related advice, as well as to share their experiences and connect with others (Fergie et al., 2016; Patel et al., 2015; Villanti et al., 2017). Social media creates virtual communities that help develop relationships with peers, reduce feelings of isolation or loneliness, increase experiential knowledge sharing, and may foster feelings of belonging (Wilson & Stock, 2021). Youth with chronic illnesses use social media to seek and provide social, emotional, and experiential support (Patel et al., 2015).

There is growing evidence that suggests that the usage of technology in providing healthcare in pediatric populations is comparable to or better than in-person care in a variety of settings and can improve outcomes such as adherence (Badawy et al., 2017a, 2017b; Radovic & Badawy, 2020; Shah & Badawy, 2021). Therefore, this study aimed to systematically review and describe the literature on technology-based peer support interventions for adolescents with chronic illness. The specific research questions addressed were: (1) Which chronic conditions do technology-based peer support interventions target?; (2) What types of technology are used?; (3) What study designs and outcomes are implemented?; (4) Are the interventions feasible and acceptable?; and (5) If sufficient intervention outcome data exist, what is the efficacy of technology-based peer support for adolescents diagnosed with chronic illness?

Methods

Design

To address the research questions, the PubMed database was queried for studies meeting inclusion through 6/28/2020. Search terms were expanded from a prior review of peer support interventions (Ahola Kohut et al., 2014) and included terms related to “youth” or “adolescents” with “chronic illness” or specific diseases, as well as “peer support” and related terms. The search algorithm is in Supplementary File 1. Only published literature was reviewed; no other methods were employed to identify relevant studies such as contacting researchers. If an article identified was a secondary analysis, the reference list was scanned to identify the primary analysis and include if not already identified.

Study Selection

Inclusion criteria were: (1) written in the English language and published in a peer-reviewed journal; (2) the mean age of participants was in the adolescent age group, defined as ages 11–21 years old (based on guidelines from the American Academy of Pediatrics, Hardin & Hackell, 2017); (3) participants were previously diagnosed with a chronic medical condition (including but not limited to those listed in the second group of search terms); (4) must evaluate an intervention, using the National Institute of Health (2017) definition of intervention as “a manipulation of the subject or subject’s environment for the purpose of one of more health-related biomedical or behavioral processes and/or endpoints”; and (5) the intervention must involve technology-based peer support with communication between peers with the same chronic illness. Technologies included but were not limited to: cell phone calls, Skype, mobile applications, text messaging, forums, social media (including Facebook, Twitter, Instagram), web games, comment exchange. Multifaceted interventions that included a peer support component were allowed. Studies were excluded if they did not meet the criteria above, including studies focusing on the prevention of a chronic condition, studies with adolescents diagnosed with a psychiatric disorder, technology interventions that did not involve active communication from a peer (e.g., automated supportive texts or reminders), studies focusing on development and/or usability testing of a prototype, protocol papers, and systematic reviews. If there were multiple publications from a single study, only the primary analysis or most recent study was included.

Review Process

First, titles and abstracts were screened using the inclusion/exclusion criteria. Next, potential studies underwent a full text review. Two independent reviewers conducted all steps; any disagreements were discussed with a third reviewer for consensus on inclusion. The numbers of studies meeting criteria through each step of the review are reported using a PRISMA flow diagram (Moher et al., 2009).

One reviewer extracted study characteristics such as author, year of publication, study design, technology used, length of intervention, participant characteristics, and results. Finally, two reviewers independently rated the quality of each study using the Evidence Project risk of bias tool (Kennedy et al., 2019). This tool was selected because it assesses risk of bias across randomized and non-randomized studies. The tool includes eight items

related to study design (i.e., whether participants are followed over time, whether a comparison group is included, whether pre/post intervention outcome data are included), participant representativeness (i.e., random assignment of participants to the intervention, random selection of participants for assessment, adequate follow-up rate of 80% or higher), and the equivalence of comparison groups (i.e., equivalence on baseline sociodemographic and baseline outcome measures). For each study, each item was rated as present, absent, not applicable, or not reported. Any discrepancies were resolved by a third reviewer.

Results

A total of 3780 articles were obtained from the search criteria and screened for inclusion. One article was added from the reference list of a secondary analysis for a total of 3781 records. After excluding studies that did not meet our inclusion criteria at the title and abstract level, the full texts of 114 studies were reviewed for inclusion. Of these studies, 32 studies met inclusion criteria. See Fig. 1 for the PRISMA flow diagram. Study characteristics and outcomes are detailed in Table 1. Papers are presented in alphabetical order, with detailed descriptions of the intervention, the type of technology used, whether the peer support component was a primary or supplemental aspect of the intervention,

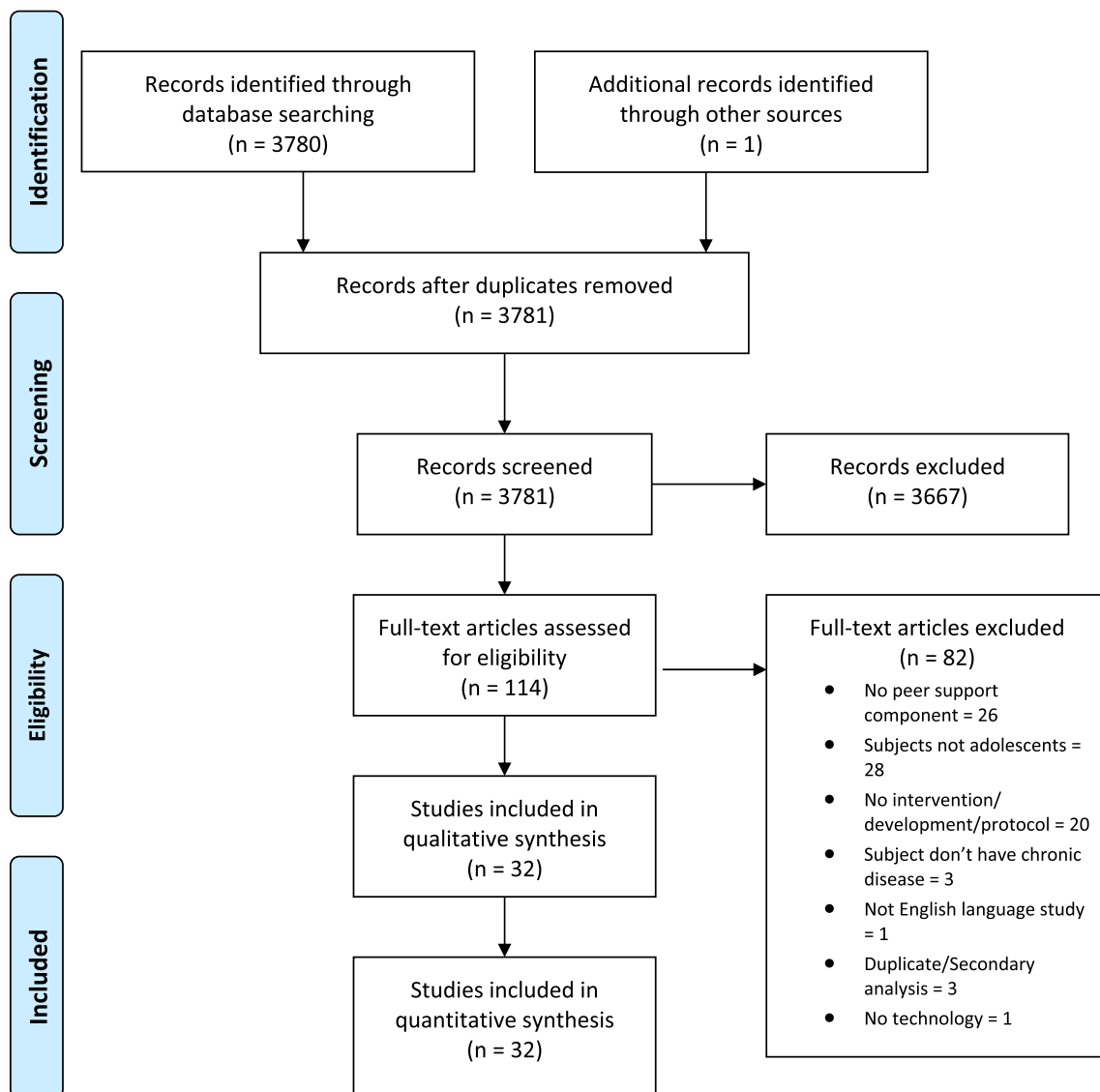


Fig. 1 PRISMA flow diagram

Table 1 Characteristics of studies included in the review

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Ahola Kohut et al. (2016) (Canada)	Skype video calls with trained peer mentors. Describing sessions of 20–30 min over 8 weeks. Call content was open-ended but could cover topics such as pain coping strategies, communicating effectively with healthcare team	Synchronous, Primary	Chronic pain	RCT	28	Mean Age: I: 14.8 years C: 14.7 years Range I: 13–18 years C: 12–17 years I: 100% female 0% male C: 87.5% female 12.5% male	8 weeks	Primary: Feasibility (i.e., accrual, dropout rate, adherence to calls, completion of surveys, qualitative satisfaction) Secondary: pain, emotional symptoms, functioning, social support, self-management, self-efficacy, pain coping	Program was feasible and acceptable 60.7% consented; 53.6% completed baseline 100% matched to peer completed calls; 40% completed within 8 weeks Mean engagement was 8.13 out of 10 Qualitative satisfaction with peer connection and advice	Significant group difference in self-management skills ($p = .02$) and satisfaction with ability to cope with pain ($p = .02$) All other secondary outcomes not statistically significant
Ammerlaan et al. (2017) (Netherlands)	Website with chat, home exercises, and discussion board Description: 6 weekly group chat sessions up to 90 min led by peer trainers. Topics included self-management, communicating with others, feeling blue, sports/exercise, relations and intimacy, and control over life/arthritis	Both, Primary	JIA	RCT	72	Mean Age: T: 19.1 years I: 19.2 years C: 19.1 years Range 16–25 T: 88% female 12% male I: 83% female 17% male C: 94% female 6% male	6 weeks	Primary: Self-efficacy Secondary: Self-management, QoL, medication use, healthcare use, absenteeism, personal learning, adherence with intervention, thematic analysis of chat content	No significant group difference in self-efficacy at 3 or 6 months	No significant group differences in secondary outcomes. Personal learning experience was rated positively (7.1 out of 10). 33 of 35 participants stayed active in the chat. Thematic analysis of the chat indicated modeling and sharing experiences were most common, followed by support, encouragement, and goal-setting

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Bers et al. (2010) (USA)	“Zora” online virtual community with chat messaging, 3-D world, group activities	Both, Primary	Transplant	Single arm, prepost	22	Mean Age: 13.7 years Range 11–15 years 45% female 55% male	9 months	Primary: Feasibility (i.e., logins, time spent, number of virtual objects created) Secondary: Qualitative perceived impact on health, adherence, and knowledge	Participants logged on a median of 19.5 times, lasting ~ 18 min/week. Participants created a median of 0.37 objects/week per participant. Creating virtual community was feasible and safe	Qualitative themes included increased sense of normalcy, enhanced sense of self and contribution, and increased social network

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Boogerd et al. (2014) (Netherlands)	“Sugarsquare” website with applications for messaging health care team, chatting with peers, tracking digital meters/pumps Description: The web-based platform has four applications (1) private messaging with healthcare team; (2) real-time chat with other uses; (3) Discussion forum for all users and professionals; and (4) link to personal digital meter/pump data. The forum and chat applications were moderated by professionals once a week	Both, Primary	T1DM	Two arms	62	Mean Age: I: 15.13 years C: 15.32 years Range 11–21 years I: 74.2% female 25.8% male C: 54.8% female 45.2% male	8 weeks	Primary: Feasibility (i.e., acceptability, demand, practicability, integration); Diabetes self-efficacy Secondary: knowledge, QoL, appreciation of diabetes care, HbA1C	Moderate-high acceptability and demand among adolescents: 20 (65%) logged in at least once; of those, 52% logged in repeatedly Practicability: low bounce percentage (5.4%); 4 of 31 could not install Integration: Use attributed to guideline concordant care Efficacy: No significant differences in self-efficacy	No between group difference in knowledge, QoL, evaluation of diabetes care, or HbA1C Within intervention group, improvement in QoL was linked with posting more chat messages ($r = .42$, $p < .05$)

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Cafazzo et al. (2012) (USA)	“Bant” mobile application with discussion board and glucometer Description: Data from participants’ glucometers is transferred to the app, bant, which provides feedback on glucose levels, rewards for adherences to testing, and gives access to peer support community	Asynchronous, Supplemental	T1DM	Single arm	20	Mean Age: 14.9 years Range 12–16 years 50% female 50% male	12 weeks	Primary: Frequency of daily blood glucose readings Secondary: HbA1c, self-care behavior, parent-adolescent interaction HbA1c, self-care behavior, parent-adolescent interaction was high (88% stated they would continue to use system)	Daily average frequency of blood glucose measurement increased 50% (from 2.4 to 3.6 per day, $p = .006$) Satisfaction was high (88% stated they would continue to use system)	No statistically significant changes in HbA1c, self-care behavior, parent-adolescent interaction around diabetes care, or QoL
Chadi et al. (2018) (Canada)	Mindfulness awareness and resilience skills program in-person or Zoom Description: 8-week evidence-informed mindfulness-based group intervention delivered in-person or via Zoom. Each 90-min session involved group discussion, mindfulness practice, and review of home practice	Synchronous; Primary	Chronic illness	Two arms, randomized trial	18	Mean age: In-person: 15.2 years Online: 15.4 years Range 13–18 years Both groups: 78% female 12% male	8 weeks	Primary: Feasibility assessed via semi-structured interviews Qualitative themes emphasized the creation of safe space, peer support, integration of mindfulness skills into daily life, and improved well-being through mindfulness	Participants reported positive experience in both groups	

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Donovan et al. (2019) (USA)	Mindfulness and social support mobile app Description: 4-week Mindfulness for Resilience in Illness Program consisted of a mindfulness mobile app, a private Facebook group (moderated by a survivor), and a provider guide. Expectations were to complete one daily meditation and respond to Facebook posts	Asynchronous; Primary	Sarcoma	Single arm	37	Mean Age: 19.3 years Range 13–25 years 50% female 50% male	4 weeks	Primary: Feasibility (i.e., usage, acceptance) Secondary: Mindfulness, perceived social support, psychological functioning, body image	Preliminary support for feasibility and acceptability. On average, participants completed 16.9 of the 28 sessions, and used the app for 10.2 days and 112.5 min. Participants reported that they enjoyed using the app ($M=5.7$ out of 7) and found the Facebook group somewhat helpful ($M=4.6$ out of 7)	No significant differences in mindfulness, perceived social support, psychological functioning, or body image

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Dulli et al. (2018) (Nigeria)	“SMART (Social Media to promote Adherence and Retention in Treatment) Connections” Facebook group with trained facilitators Description: Following an in-person meeting, trained facilitators led 5 sessions via private Facebook groups. Adapted from an existing support group guide, Positive Connections. Topics included understanding HIV; disclosure and developing trust in relationships; treatment and adherence; nutrition and health; and sex and relationships	Asynchronous Primary	HIV	Single arm, prepost	41	Mean Age: 17 years Range 15–19 years 53% female 47% male	5 weeks	Primary: Feasibility (i.e., log ins, forms of engagement, level, acceptance)	97% of participants posted or commented at least once; half posted in all sessions Engagement levels varied widely. 29% of participants had a very low engagement level (0–5 posts or comments) and 18% had a very high engagement level (51–237 posts or comments) Qualitative satisfaction with peer interaction	N/A

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Dulli et al. (2020) (Nigeria)	“SMART (Social Adherence and Retention in Treatment) Connections” Facebook group with trained facilitators Description: Following an in-person meeting, nearly daily activities delivered through private Facebook group led by a trained peer facilitator over a span of 22 weeks (2 weeks per session topic). Adapted from an existing support group guide, Positive Connections. Topics included disclosure, nutrition and health, reproductive rights, discrimination and rights, and planning for your future	Asynchronous Primary	HIV	RCT	349	Mean Age: 21 years Range 15–24 years 85.3% female 14.7% male	22 weeks	Primary: Retention in care (defined as not missing an appointment by more than 28 days) Secondary: antiretroviral (ART) treatment adherence, HIV knowledge, social support, stigma, depression	No statistically significant difference in retention in care. Retention was high at 75.7% in intervention and 83.4% in control	HIV-related knowledge significantly better in the intervention group ($p = .03$) No statistically significant difference in ART adherence, social support, social isolation, stigma, or depression 96.8% of participants would recommend this Facebook group to other young people living with HIV

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Francis et al. (2020) (Australia)	Mobile app. Description: Participants used the “CyFi” mobile app for 6 weeks. Features included chat messaging, medication reminders, mood monitoring, and wellness tips	Both, Primary	Cystic fibrosis	Single arm	22	Mean Age: 14.64 years Range 12–17 years 50% female 50% male	6 weeks	Primary: Feasibility (i.e., usability, acceptability)	77% of participants used the app at least once a week 77% of participants would recommend the app to others 45% of participants reported that the app helped make them feel more connected to other young people with a chronic condition	N/A

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Freedenberg et al. (2017) (USA)	In-person, mindfulness-based stress reduction (MBSR) program compared to active control online support group Description: Six weekly 90-min MBSR in-person groups vs. weekly 60-min online group via Skype. Support sessions were facilitated by a group leader and were composed of discussions about health topics plus free time for group discussions on any topic of the participants' choosing	Synchronous, Primary	Cardiac disease	Two arms, randomized trial	46	Mean Age: I: 15.1 years C: 14.5 years Range 12–18 years I: 69% female 31% male C: 55% female 45% male	6 weeks	Primary: Illness-related stress, anxiety, and depression Secondary: Coping, social support	Both groups showed a significant reduction in illness-related stress ($p = .001$) and stress did not differ significantly between the two groups. No significant differences in other primary outcomes	Both groups showed significant increases in coping ($p = .028$) and coping did not differ significantly between the two groups. Both groups report increased social support and reduced distress
Gonzalez-Morkos et al. (2014) (USA)	"Teen Impact": support group Description: Twice monthly support group led by facilitator. During H1N1 flu restrictions, 3 of 9 meetings had both in-person participants and live webcast (phone or instant messaging)	Synchronous, Primary	Cancer or blood disorder	Single arm	6	Mean Age: NR Range 15–18 years 33% female 67% male	5 Months	Primary: Feasibility assessed via qualitative interview	Prior live group members were dissatisfied with webcast due to lack of physical interaction New members report webcast was a positive experience; felt supported by peers, liked sense of anonymity	N/A

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Grey et al. (2013) (USA)	Compared two internet-based educational programs: TEENCOPE and Managing Diabetes	Asynchronous, Secondary	T1DM	Two arms, randomized trial	320	Mean Age: 12.3 years Range 11–14 years 55% female 45% male	12 months	Primary: HbA1c, QoL Secondary: engagement, coping, self-efficacy, social competence, self-management, and family conflict	QoL significantly improved in both groups at 12 mo. ($p < .001$), but no differences between groups. Both groups had slight increases in HbA1c levels at 12 mo. ($p = .05$), but no differences between groups	TEENCOPE participants completed 82% of sessions; Managing Diabetes completed 74% of sessions. Managing Diabetes group had significantly less diabetes family conflict compared to TEENCOPE group ($p = .02$). No other differences in secondary outcomes

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Griffiths et al. (2015) (England)	“Realshare” Website with discussion forum, chat messaging Description: Participants used an online community over two 3-month periods – with and without a facilitator present. Facilitators prompted discussions	Both, Primary	Cancer	Single arm	12	Mean Age: 21.08 years Range 16–30 years 58.3% female 41.7% male	6 months	Primary: Feasibility and preferences for facilitation Secondary: Qualitative reports on experience, overall impression of the website	Number of messages doubled w/facilitator (i.e., 43 messages without facilitator and 102 with facilitator) Facilitator viewed as positive in prompting participants, starting discussion threads, and connecting members to each other	Participants reported intervention could help young people feel part of the community and reduce isolation Participants expressed concern for Realshare to maintain active user base
Hacking et al. (2019) (South Africa)	Peer mentorship via mobile phone calls or messaging Description: Trained peer mentors interact with mentees via text, WhatsApp, or call. Duration and content not specified, but mentorship concluded with an invitation to attend the next HIV youth-adherence club	Synchronous, Primary	HIV	Two arms	40	Mean Age: NR, median age: 20.42 years Range 12–25 years 95% female 5% male	2–8 weeks	Primary: Engagement with HIV services, Antiretroviral initiation, retention in care, viral load suppression Secondary: Qualitative acceptability and impact of program	Mentees had increased antiretroviral initiation and viral load completion compared to matched controls No differences in viral load suppression or retention in care at 6 or 12 months	Mentors felt motivated due to prior struggles and a desire to help peers. Mentees reported barriers to care and fears of disclosure. They viewed mentors positively and valued talking openly

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Iafusco et al. (2011) (Italy)	Physician-moderated chat messaging Description: Weekly 90-min chat moderated by physician. Topics were chosen and voted on by participants at beginning of session – could include diabetes management or daily life and relationships	Synchronous; Primary	T1DM	Two arms	193	Mean Age: I: 13.6 years C: 14.1 yrs Range 10–18 years I: 56% female 44% male C: 48.3% female 51.7% male	2 years	Primary: Diabetes-specific QoL, HbA1C	Significant improvement in QoL in patients who participated in chat sessions Significant improvement in HbA1C in intervention group (0.4%) but not in controls (0.1%), but between group not significant ($p = .06$)	N/A
Johnson et al. (2001) (USA)	Website with message board, email quizzes Description: Website with different active components, including personal diary, social messaging board, CF education. Users could take quizzes, email other users, participate in special community events	Asynchronous, Primary	CF	Prepost, two arms cross-over trial	18	Mean Age: NR, median age: 13 years Range 13–18 years Sex NR	10 months	Primary: Feasibility (site access and usage) Secondary: Knowledge, perceptions of support, attitudes about site	Users logged into the site an average of 4 times per month over the study Posting messages to the Message Board was most common interaction 77% reported emailing peers at least every other week	No significant difference in CF knowledge Significant increase in perceptions of support from peers with CF (1.9 vs 9.2; $p = .02$)

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Letourneau et al. (2012) (Canada)	Online chat sessions facilitated by trained peer mentors, with email and discussion boards Description: 12 weekly synchronous chat sessions moderated by trained peer mentors to provide informational, affirmational, and emotional support. Participants could also email and post discussion board message	Synchronous, Primary	Asthma, allergies	Single arm, prepost	28	Mean Age: 13 years Range 11–16 years 42.9% female 56.1% male	3 months	Primary: Support-seeking coping, support satisfaction, social network size, loneliness/ social isolation, self-efficacy Secondary: Social isolation Qualitative impact of the intervention	No statistically significant change in support-seeking, support satisfaction, social network size, or loneliness/ social isolation, self-efficacy Social isolation and loneliness were significantly reduced	Youth reported gaining confidence, a sense of normality, and comfort coping with difficult social situations like bullying

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Mendoza et al. (2017) (USA)	FitBit and Facebook group Description: 10-wk intervention consisted of a physical activity tracker and a private Facebook group for peer support, moderated by study staff	Asynchronous, Primary	Cancer survivors	Two arms, randomized trial	60	Mean Age: I: 16.9 years C: 16.3 years Range 14–18 years I: 58.6% female 41.4% male C: 60.0% female 40.0% male	10 weeks	Primary: Feasibility (i.e., number of eligible enrolled, number of days tracker worn, number of participants completing measures) Secondary: Moderate/vigorous physical activity (accelerograph), QoL, engagement in Facebook group, self-determination theory constructs; qualitative acceptability	All 3 feasibility benchmarks were achieved Enrolled target of 60 Participants wore the activity tracker on average 71.5% of days 100% of participants at Time 1 completed measures; 90% at Time 2	No significant differences in moderate-to-vigorous activity or sedentary time between groups No significant change in QoL scores, with exception of social subscale Participants who engaged in the Facebook group had non-significant improvements in activity compared to those without any engagement Qualitative results were positive, with suggestions for improvement

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Newton and Ashley (2013) (USA)	Website with discussion forum, chat room, and blog Description: Participants were encouraged to log into the website at least 3 times per week to update their blogs and participate in discussion forums. Moderator hosted weekly chat session. Topics included frustrations with diabetes; benefits of good control, family, friends, body image, community activities, and diabetes worries	Both, Primary	T1DM	Two arms	59	Mean Age: I: 14 years C: 15 years Range 13–18 I: 80% female C: 52% female	7 weeks	Primary: Feasibility (i.e., recruitment, retention, website usage) Secondary: QoL, self-efficacy, outcome expectations	59 of 81 (73%) recruited completed the pre-test 50 OF 59 (85%) completed the study There was a general decline in the number and duration of website visits from beginning to end of study Chat rooms had the most views (171 hits per day), followed by discussion forums (92 hits per day) and blogs (43 hits per day)	There was no significant treatment × time effect on outcome measures ($p = .052$) Youth provided positive qualitative comments about participating
Nicholas et al. (2012) (Canada)	Website with interactive learning activities and discussion board Description: 8-week online text-based program moderated by social worker. Topics included self-care, transitional issues, bullying, self-management strategies, managing difficult situations, and relationships	Asynchronous, Primary	T1DM	RCT	31	Mean Age: 14.5 years Range 12–17 years NR% female NR% male	8 weeks	Primary: Social supportive qualitative impact of participation	Non-significant gains in participants' relationship quality with others ($p = .052$) Participants report decreased isolation, knowledge gain, normalization of experience	N/A

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Petrovski and Zivkovic (2019) (Macedonia)	Facebook group Description: Closed Facebook or Viber group to allow questions and discussion on diabetes care. Posts typically included: carbohydrate counting, low and high blood sugar treatment, insulin infusion troubleshooting, new treatment options, and other issues	Asynchronous, Primary	T1DM	Two arms	728	Mean Age: I: 16.4 years C: 15.2 years Range 11–25 years I: 57.3% female 42.7% male C: 56.5% female 43.5% male	5 years	Primary: HbA1C, diabetic ketoacidosis events, hypoglycemia events, total daily insulin	Engagement was high (1.5 ± 3.5 posts/day) 64% of patients shared their last HbA1C in the group HbA1C was significantly lower in patients using Facebook group (7.1 ± 3.2%, 7.6 ± 2.8%, $p < .05$) All other primary outcomes not significant	N/A
Plevinsky and Greenley (2014) (USA)	Facebook group Description: 8-week private Facebook group following a week-long in-person camp. In first 2 weeks, participants were free to post about any topic; after 2 weeks, a facilitator posted biweekly questions related to living with IBD to encourage group interaction	Asynchronous, Primary	IBD	Single arm, prepost	21	Mean Age: 15.33 years Range 14–17 years 81% female 19% male	2 months	Primary: HRQoL, social functioning	HRQoL decreased from post-camp to post-Facebook group ($d = -.26$), but there was a net increase overall from baseline ($d = .17$). Improvement in social functioning ($d = .21-.32$) from postcamp to post-Facebook assessment	N/A

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Prout Parks et al. (2018) (USA)	Facebook group Description: 12-week private Facebook group moderated by psychologist who posted nutrition, exercise, and behavior change challenges, goal-setting, and videos 3–4 times per week. Adjunct to clinical visits	Asynchronous, Primary	Severe obesity	Single arm	13	Mean Age: 16 years Range 14–20 years NA% female 30.8% male	12 weeks	Primary: Acceptability and Feasibility Secondary: Clinic attrition, effect of social media engagement on BMI and psychosocial outcomes	Youth remained engaged in social media weekly (likes/comments > 4 times per week), mean 8.6 (SD 3.6). Youth “liked” more than they “commented”	No significant change in clinic visit attendance after the intervention, suggesting no increase in attrition, which may be expected. Increased social media comments correlated with weight change ($r = -.63$, $p = .04$)
Raymond et al. (2016) (USA)	Individual and group telemedicine appointment: One 20–30 min individual appointment with diabetes provider and a 30-min group appointment facilitated by a certified diabetes educator. Topics included stress management, support systems, diabetes management, high-risk activities, insulin pumps, burnout, and their diabetes story	Synchronous, Primary	T1DM	Single arm	45	Mean Age: 19.8 years Range 18–25 years 55.8% female NA% male	1 day (1 study visit)	Primary: Feasibility	Feasible, acceptable, easy to use 41 patients (91%) completed both individual and group appointments 92% agreed or strongly agreed to the statement: “I would recommend this technology to others” High perceived support from peer interaction	N/A

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Sansom-Daly et al. (2019) (Australia)	Recapture Life: peer support group via videoconference Description: 6 weekly small-group videoconference sessions facilitated by psychologists to address challenges of cancer survivorship and learn evidence-based cognitive-behavioral coping strategies. Receive workbook with weekly at-home practice and may invite a support person to participate	Synchronous, Primary	Cancer survivors	RCT	45	Mean Age: 20.6 years Range 15–25 years 51.1% female 48.9% male	14 months	Primary: Feasibility (i.e., recruitment rates, days to group commencement, technology issues), psychological safety, acceptability (i.e., retention, benefit, burden)	The opt-in rate was 30% and enrollment rate 87%. 92% completed the program and 67% completed the follow-up. 75% took part in ≥5/6 sessions 40 concerning distress scores reported, but no safety issues. Participants reported high benefit and low burden of participation. Multiple indices support feasibility but also highlight challenges in recruitment and technology delivery	N/A

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Scalzi et al. (2018) (USA)	Educational website with discussion forum Description: 8 weekly educational modules about SLE, including transition to self-management, learning about lupus, medications, symptoms, family, friends, stress, and goals. Participants were randomized to respond to questions at the end of each session on a social media forum with other participants or in a journal (control)	Asynchronous, Supplemental	SLE	Two arms, prepost	27	Mean Age: I: 18.2 years C: 18.1 years Range 13–23 years I: 100% female NA% male C: 93% female NA% male	8 weeks	Primary: Feasibility (i.e., recruitment, compliance and drop out) Secondary: Medication adherence, self-efficacy, QoL, empowerment, stress, agency	Twenty-seven of the 37 enrolled (73%) completed the study. Ten (27%) were lost to follow-up	The percentage of the intervention group that was adherent significantly improved from 50 to 92% ($p = .03$) Significant improvement in self-efficacy ($p = .04$), agency ($p = .03$) and sense of community ($p = .03$) in intervention group compared to control
Stinson et al. (2016) (Canada)	Skype video calls with trained peer mentors Description: 10 sessions of 20–30 min Skype video calls with a sex-matched trained peer mentor over 8 weeks. Conversation topics were not predetermined by the protocol	Synchronous, Primary	JIA	RCT	30	Mean Age: I: 14.11 years C: 14.42 years Range 12–18 years I: 94% female 6% male C: 100% female 0% male	8 weeks	Primary: Feasibility (i.e.; recruitment, withdrawal, adherence with the program, engagement, satisfaction) Secondary: Self-management, pain, perceived social support, HRQoL	32% of those approached completed baseline measures and were randomized 5.1% of participants withdrew Half of participants completed the goal of 10 calls, lasting on average 44.72 min Participants reported mean engagement of 8.53 out of 10	Improved perceived ability to manage JIA compared to controls

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Troncone et al. (2019) (Italy)	Online chat with moderator Description: Weekly online chat sessions moderated by a diabetes provider (physician, psychologist, or nurse). Topics were chosen by group members at beginning of session	Synchronous, Primary	T1DM	Single arm	161	Mean Age: 13.92 years Range 12–18 years 45.9% female 54.1% male	10 months	Primary: Content analysis evaluating social support	Topics discussed included self-management, diabetes-related concerns, nutrition, emotional impact of disease About 30.64% of messages provided social support	N/A
Whitemore et al. (2010) (USA)	TEENCOPE website for coping skills training with discussion board or Managing Diabetes educational website Description: TEENCOPE is an online coping skills training consisting of 5 weekly sessions on self-talk, communication skills, social problem skills, stress management, and conflict. Managing Diabetes consisted of 4 weekly sessions on glucose control, nutrition, exercise and sick days, and new technology	Asynchronous, Supplemental	T1DM	Two arms, randomized trial	12	Mean Age: 14.4 years Range 13–16 years 58% female 42% male	6 months	Primary: Feasibility, acceptability Secondary: HbA1C, stress, coping, QoL, self-efficacy, psychosocial adjustment	Feasible and acceptable. TEENCOPE participants had twice as many logins over the duration of the program Satisfaction was high	No significant differences in HbA1C, stress, coping, QoL, self-efficacy, psychosocial adjustment

Table 1 (continued)

Publication (country)	Technology intervention	Peer communication style (Synchronous, asynchronous, or both) & approach (Primary, supplemental)	Population	Study design	Sample size	Sample characteristics	Length of intervention	Outcome(s)	Results: primary	Results: secondary
Whittemore et al. (2016) (USA)	“Teen.Connect” and “Planet D” websites with discussion boards Description: Teen.Connect consists of two elements, TEENCOPE (an interactive web-based coping skills training) and Managing Diabetes (an internet-based educational program that focuses on problem-solving); Planet D is a website developed by the American Diabetes Association for diabetes education and social networking discussion boards	Asynchronous, Supplemental	T1DM	Two arms, randomized trial	124	Mean Age: Teen.Connect: 12.1 years Planet D: 12.2 years Range 11–14 years Teen.Connect: 62% female Planet D: 63.3% female 36.7% male	12–18 months	Primary: Participation (i.e., number of logins, post board, lessons completed), A1C, QoL Secondary: diabetes self-efficacy, self-care, perceived stress, depressive symptoms	Satisfaction and logins were similar between groups (satisfaction ranged 3.3–3.5/5; mean logins = 14/teen) At 6 months, no significant differences in A1C or QoL between groups	No significant differences for any of the secondary outcomes between groups Teens in the Teen.Connect reported lower perceived stress over time ($p < .01$)
Yi-Frazier et al. (2015) (USA)	Post photos to Instagram Description: Participants posted photos to Instagram that represented anything about diabetes. Participants were encouraged but not required to caption their photos with a study-specific hashtag	Asynchronous, Primary	T1DM	Single arm	20	Mean Age: 16.4 years Range 14.8–18 years 65% female 35% male	3 weeks	Primary: Feasibility (i.e.; enrollment, recruitment, retention) Secondary: Content analysis of the Instagram posts	20/47 (43%) patients approached were recruited 12/20 (60%) actively participated in posting photos	33% of photos posted were taken by participants, the remaining were “internet memes.” Photos were characterized as diabetes care, humor, food, exercise/sports and life with diabetes Participants found the project positive

USA USA PRO patient-reported outcome, RCT randomized controlled trial, T1DM Type 1 Diabetes Mellitus, SLE systemic lupus erythematosus, CF cystic fibrosis, wk week, mo month, QoL quality of life

participant characteristics, primary and secondary outcomes, and results.

Populations

The average age of subjects ranged from 12.1 to 21 years old. The sample sizes ranged from 6 to 728, with a mean number of 84.7 subjects and median of 34. Only six studies (19%) had sample sizes greater than 100. Sixteen studies (50%) were conducted in the USA; five (16%) were conducted in Canada. Interventions targeted adolescents with a number of different chronic conditions. The condition most represented in these studies was Type 1 diabetes mellitus (T1DM; $n = 12$ studies). Five studies involved adolescents with cancer across the cancer survivorship trajectory ($n = 5$). Other conditions studied included: human immunodeficiency virus (HIV; $n = 3$), cystic fibrosis ($n = 2$), juvenile idiopathic arthritis (JIA; $n = 2$), solid organ transplant ($n = 1$), cardiac disease ($n = 1$), chronic pain ($n = 1$), any chronic illness ($n = 1$), severe obesity ($n = 1$), inflammatory bowel disease (IBD; $n = 1$), lupus ($n = 1$), asthma and allergies ($n = 1$).

Types of Technology

There were myriad technologies used including Facebook groups, chat messaging, Instagram, websites with discussion forums, mobile applications (“apps”), online environments, and online video conferencing interfaces. Types of communication included synchronous ($n = 11$ studies), asynchronous ($n = 15$ studies), or both ($n = 6$ studies). Discussion forums, where group members can post to all members of the group, were the most common feature utilized within these interventions ($n = 18$ studies). Within these 18 studies, Facebook was used in six studies and the remaining studies used other types of asynchronous message forums. In general, these groups were private for study participants rather than being open to the public.

Nine studies used chat messaging, including text messaging. Chat was often one of several features of an intervention. Videoconferencing was included in 7 studies, with use of Skype ($n = 3$), Zoom ($n = 1$), Vidyo ($n = 1$), and other unspecified platforms ($n = 2$). Email messaging was included in two interventions. Three studies created mobile phone applications.

Authors also commented on the involvement of facilitators who monitored and prompted conversations. There was variability in who the facilitators were if they were used. Health care providers were the facilitators in several of the studies (Gonzalez-Morkos et al., 2014; Griffiths et al., 2015; Letourneau et al., 2012; Tronccone et al., 2019), with one study also using peer mentors as facilitators (Letourneau et al., 2012).

Study Designs and Outcomes

All studies were published within the past ten years, except for one study published in 2001 (Johnson et al.). Twenty of the studies were published in the past 5 years. The majority of the studies were single arm studies ($n = 22$ feasibility studies; $n = 1$ content analysis). There were 12 randomized two-arm trials and two unique study designs. The study described by Johnson et al. (2001) used a modified waitlist control design. The study described by Gonzalez-Morkos et al. (2014) utilized a single arm design, but one subdivision of the participants attended a live, in-person intervention, while another subdivision participated via webcast. This was due to the H1N1 pandemic, in which certain patients were not able to attend the live session safely due to concern for infection (Gonzalez-Morkos et al., 2014).

The primary outcome for most studies was feasibility ($n = 22$). Other outcomes include A1C (Boogerd et al., 2014; Grey et al., 2013; Iafusco et al., 2011; Whittemore et al., 2010, 2016), quality of life (Ammerlaan et al., 2017; Grey et al., 2013; Iafusco et al., 2011; Newton & Ashley, 2013; Plevinsky & Greenley, 2014; Whittemore et al., 2010, 2016;), disease knowledge (Boogerd et al., 2014; Dulli et al., 2020; Johnson et al., 2001), social support (Dulli et al., 2020; Letourneau et al., 2012; Nicholas et al., 2012), self-management (Ammerlaan et al., 2017; Newton & Ashley, 2013), medication initiation or adherence (Dulli et al., 2020; Hacking et al., 2019; Scalzi et al., 2018), retention in care (Dulli et al., 2020), stress and coping (Freedenberg et al., 2017; Whittemore et al., 2010), anxiety and depression (Freedenberg et al., 2017), disease activity (Ammerlaan et al., 2017), viral load suppression (Hacking et al., 2019), retention in healthcare (Ammerlaan et al., 2017; Dulli et al., 2020), engagement with healthcare (Hacking et al., 2019), and absenteeism (Ammerlaan et al., 2017).

Feasibility and Acceptability

All of the studies found interventions to be feasible and acceptable to participants. The majority of studies used a mixed methods approach, in that data were obtained about how frequently the technology was used and followed up with qualitative interviews. Participants reported positive engagement with the intervention in most studies ($n = 22$) (Ammerlaan et al., 2017; Boogerd et al., 2014; Cafazzo et al., 2012; Chadi et al., 2018; Donovan et al., 2019; Dulli et al., 2018; Francis et al., 2020; Mendoza et al., 2017; Prout Parks et al., 2018). In one study, subjects that had previously performed the intervention in a live setting were unsatisfied when it was changed to delivery via technology, but participants who first participated in the technology intervention found it satisfactory (Gonzalez-Morkos et al., 2014).

Participant engagement data were variable across studies and was measured differently depending on type of technology (e.g., number of messages posted, number of sessions completed). Studies found anywhere from 50 to 75% of participants met participation milestones such as posting in sessions or completing videoconferences (Dulli et al., 2018; Sansom-Daly et al., 2019; Stinson et al., 2016; Yi-Frazier et al., 2015). One study found that the number of messages exchanged doubled with the use of a facilitator (Griffiths et al., 2015). Overall, adolescents found the technology easy to use (Francis et al., 2020; Johnson et al., 2001; Raymond et al., 2016).

Efficacy

While most studies ($n = 22$) concluded that these types of interventions were feasible, several also evaluated intervention effects on mental and physical health outcomes. Thirteen interventions positively impacted social support, social network, or isolation (Ammerlaan et al., 2017; Bers et al., 2010; Chadi et al., 2018; Donovan et al., 2019; Dulli et al., 2020; Freedenberg et al., 2017; Gonzalez-Morkos et al., 2014; Griffiths et al., 2015; Johnson et al., 2001; Letourneau et al., 2012; Nicholas et al., 2012; Plevinsky & Greenley, 2014; Raymond et al., 2016). While four of these studies identified statistically significant improvement on measures of social support (Johnson et al., 2001; Letourneau et al., 2012; Nicholas et al., 2012; Plevinsky & Greenley, 2014), at least seven of the studies reported improved social support as a qualitative outcome from interview data. Two studies demonstrated no significant change in social support measures (Donovan et al., 2019; Dulli et al., 2020). Effect sizes were not reported or small (e.g., Cohen's $d = .2$ to $.3$).

Other commonly reported outcomes were HbA1C (in studies involving adolescents with T1DM), and quality of life (in studies of patients with T1DM, IBD, and cancer). For studies evaluating HbA1C, three studies showed improvement in levels compared to baseline (Boogerd et al., 2014; Iafusco et al., 2011; Petrovski & Zivkovic, 2019), while three other studies showed no change (Grey et al., 2013; Whittemore et al., 2010, 2016). Similarly, for studies evaluating quality of life, three showed improvements (Boogerd et al., 2014; Iafusco et al., 2011; Plevinsky & Greenley, 2014), and four showed no change from baseline (Mendoza et al., 2017; Newton & Ashley, 2013; Whittemore et al., 2010, 2016). One study found a significant decrease in illness-related stress in patients with cardiac disease (Freedenberg et al., 2017).

Other studies focused on disease self-management. Among studies that evaluated self-management and self-efficacy as an outcome, half of the studies demonstrated improvement (Ahola Kohut et al., 2016; Grey et al., 2013; Stinson et al., 2016), while the other half demonstrated

no change (Ammerlaan et al., 2017; Boogerd et al., 2014; Newton & Ashley, 2013). Studies evaluating changes in disease knowledge found no significant differences in disease knowledge in patients with CF (Johnson et al., 2001) and in patients with HIV (Dulli et al., 2020). Three studies evaluated continued engagement with health care facilities and found no difference from baseline (Dulli et al., 2020; Hacking et al., 2019; Prout Parks et al., 2018).

Quality Review

As demonstrated in Table 2, there were several potential biases present in the studies reviewed. Although most studies ($n = 19$ of 32) had a control or comparison group, four of those 19 did not randomly assign participants to the groups or did not report about this aspect. Within studies that had a comparison group, only three studies reported that the comparison groups were equivalent on both sociodemographic and outcomes at baseline; the remaining were not reported or not equivalent and therefore failed to control for confounders. None of the studies randomly selected participants for assessment, as most solely recruited convenience samples from clinic, suggesting potential for selection bias and limiting the generalizability of these studies. Only thirteen studies demonstrated a follow-up rate of 80% or more, further limiting the generalizability of these studies.

Discussion

Given the omnipresence of technology in modern adolescents' daily lives (Anderson & Jiang, 2018) and its potential to overcome access barriers to reach social support, this review examined the current landscape of technology-based peer support interventions among teens with chronic disease, including whether such interventions are acceptable and useful for adolescents. The total number of studies meeting inclusion criteria was 32, which represents an overall dearth of studies relative to the scope of the search. Almost all of the studies were published in the past ten years, coinciding with the surge of social media and daily technology use within society more broadly, as well as researcher interest in harnessing mobile technologies for health (Faiola et al., 2019; Perrin, 2015).

The studies used a variety of technologies to facilitate peer support. Discussion boards utilizing asynchronous communication were overwhelmingly popular. Facebook groups also utilize asynchronous messaging, and, in addition, offer an interface that is readily used in daily life. Other studies used video conferencing or developed novel mobile applications. Interestingly, all of the studies using video conferencing were published in 2016 or later, suggesting a more recent trend toward video conferencing. Despite extremely high

Table 2 Quality assessment of articles using the Evidence Project risk of bias tool

	Cohort?	Control or comparison group?	Pre/post intervention data?	Random assignment of participants to the intervention?	Random selection of participants for assessment?	Follow-up rate of 80% or more?	Comparison groups equivalent on sociodemographics?	Comparison groups equivalent on outcomes at baseline?
Ahola Kohut et al. (2016)	Yes	Yes	Yes	Yes	No	Yes	N.R	N.R
Ammerlaan et al. (2017)	Yes	Yes	Yes	Yes	No	No	Yes	N.R
Bers et al. (2010)	Yes	No	No	N/A	No	Yes	N/A	N/A
Boogerd et al. (2014)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Cafazzo et al. (2012)	Yes	No	Yes	N/A	No	No	N/A	N/a
Chadi et al. (2018)	Yes	Yes	Yes	Yes	No	No	No	N/A
Donovan et al. (2019)	Yes	No	Yes	N/A	No	Yes	N/A	N/A
Dulli et al. (2018)	Yes	No	Yes	N/A	No	Yes	N/A	N/A
Dulli et al. (2020)	Yes	Yes	Yes	Yes	No	No	Yes	N.R
Francis et al. (2020)	Yes	No	No	N/A	No	N.R	N/A	N/A
Freedenberg et al. (2017)	Yes	Yes	Yes	Yes	No	Yes	N.R	No
Gonzalez-Morkos et al. (2014)	Yes	No	No	N/A	No	No	N/A	N/A
Grey et al. (2013)	Yes	Yes	Yes	Yes	No	No	No	Yes
Griffiths et al. (2015)	Yes	No	Yes	N/A	No	No	N/A	N/A
Hacking et al. (2019)	Yes	Yes	Yes	No	No	No	Yes	Yes
Iafusco et al. (2011)	Yes	Yes	Yes	No	No	Yes	Yes	N.R
Johnson et al. (2001)	Yes	Yes	Yes	N.R	No	N.R	N.R	N.R
Letourneau et al. (2012)	Yes	No	Yes	N/A	No	No	N/A	N/A
Mendoza et al. (2017)	Yes	Yes	Yes	Yes	No	Yes	N.R	N.R
Newton and Ashley (2013)	Yes	Yes	Yes	Yes	No	Yes	N.R	N.R
Nicholas et al. (2012)	Yes	Yes	Yes	Yes	No	N.R	N.R	N.R
Petrovski and Zivkovic (2019)	Yes	Yes	Yes	No	No	N.R	No	N.R
Plevinsky and Greenley (2014)	Yes	No	Yes	N/A	No	Yes	N/A	N/A
Prout Parks et al. (2018)	Yes	No	Yes	N/A	No	Yes	N/A	N/A

Table 2 (continued)

	Cohort?	Control or comparison group?	Pre/post intervention data?	Random assignment of participants to the intervention?	Random selection of participants for assessment?	Follow-up rate of 80% or more?	Comparison groups equivalent on sociodemographics?	Comparison groups equivalent on outcomes at baseline?
Raymond et al. (2016)	Yes	No	No	N/A	N/A	Yes	N/A	N/A
Sansom-Daly et al. (2019)	Yes	Yes	Yes	Yes	No	No	N.R	N.R
Scalzi et al. (2018)	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Stinson et al. (2016)	Yes	Yes	Yes	Yes	No	No	N.R	N.R
Troncione et al. (2019)	Yes	No	No	N/A	No	N/A	N/A	N/A
Whittemore et al. (2010)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Whittemore et al. (2016)	Yes	Yes	Yes	Yes	No	No	No	No
Yi-Frazier et al. (2015)	No	No	No	N/A	No	No	N/A	N/A

N.R. not reported, *N/A* not applicable

use of mobile phones by adolescents (Anderson & Jiang, 2018), very few studies relied on mobile technology or text messaging. Likewise, as of 2018, YouTube, Instagram, and Snapchat were the most popular online tools used by teens, though only one included study involved Instagram (Yi-Frazier et al., 2015). Thus, variability in engagement seen within the different studies may be due in part to inconsistency between the types of technology that teens use for their own social connection and what is being used in research studies. Additionally, facilitator differences, such as whether they were known to the subjects as part of the healthcare team versus a peer facilitator, as well as the degree to which facilitators prompted users, likely influenced the extent of participation and candor of exchange between participants. It is important that researchers continue to define and report on the characteristics and involvement of facilitators such that more thorough and repeatable analyses can be performed on their utility.

The state of the literature on peer support for chronic illness reflects mostly feasibility and acceptability studies, with 22 of the 32 studies reviewed being feasibility studies. This is consistent with a prior review of peer mentoring studies in adolescents with chronic disease that was not specific to technology (Ahola Kohut et al., 2014). The large proportion of feasibility studies underscores the early phase of development for these interventions, in part due to the rapidly evolving field of eHealth.

Though efficacy studies were limited, half were conducted with youth with T1DM. However, outcomes varied widely across studies and there is too little data to make

conclusions regarding efficacy. Additionally, the overall rigor of most studies was low to moderate, with a minority of studies being randomized studies ($n = 12$), possible selection bias, and difficulties with retention. Of the studies that measured quantitatively measured medical outcomes ($n = 10$), 6 studies had a large study size (> 72 participants) and 2 studies showed statistically significant results. Nonetheless, general trends in the data were apparent. Importantly, the general satisfaction of participants across studies was notable, suggesting adolescents find these types of interventions acceptable. Indeed, several studies indicated that participants contacted each other outside of the study (Griffiths et al., 2015; Johnson et al., 2001; Raymond et al., 2016). This presumed openness to continuing a relationship outside of the technology intervention suggests that participants are engaging in meaningful relationships.

Strengths of the current review include the focus on technology-based interventions, which is timely given the increased reliance on technology among youth and in healthcare. Additionally, we followed the PRISMA guidelines to conduct a rigorous review, used extensive search terms to identify relevant studies, and had two independent reviewers conduct each step of screening.

The current review was limited in that it included only published data in English language from a single database, which may introduce publication bias, as null or negative findings may be less likely to be published, and may have missed relevant articles published in other databases. However, PubMed/MEDLINE is the largest, most relevant database for this search focusing on the intersection of chronic

illness and behavioral interventions. Limitations of the literature more broadly include the wide variability in behavioral targets, validated measures, and outcomes across studies, making it difficult to compare across studies and draw conclusions. Most study designs reflect early development and feasibility work ($n = 22$), with a focus on mixed methods and qualitative results. The targeted age range for studies varied; one study found non-significant differences in the use of different features by age (e.g., older participants used the medication reminders more, while younger participants like the virtual computerized buddy check-in; Francis et al., 2020). No study evaluated whether response to the intervention differed as a function of age or developmental maturity. Future research should consider these factors in the development and evaluation of peer support interventions. There was a paucity of quantitative health outcome endpoints, making it difficult to synthesize outcome data at this time. Additionally, nearly one third of the studies identified in the current literature were focused on patients with T1DM. As the disease experiences and needs of patients vary greatly across disease populations, the generalizability of these results may be limited due to many studies with one population.

Together, these studies demonstrate feasibility and acceptability of using technology to facilitate peer support among adolescents with chronic disease. These results are consistent with other literature demonstrating the feasibility, acceptability, and beneficial effects of telehealth and other digital interventions on quality of life, symptom management, medication adherence, and satisfaction outcomes among children and adolescents (Radovic & Badawy, 2020; Shah & Badawy, 2021). There is a need for more rigorous evaluation of efficacy, including adequately powered randomized controlled trials, prior to recommending widespread clinical application of these interventions. Related topics within the field, such as telemental health for adolescents and electronic mentoring for youth with disabilities, demonstrate similar limitations in the number of high quality randomized control trials performed (Lau et al., 2021; Lindsay et al., 2018). Peer support in adults with diabetes has been rigorously studied using randomized controlled trials, which allow for efficacy study; this should be looked to as a goal for the field (Qi et al., 2015). Future studies should specify the behavioral targets of each intervention and the outcomes expected to change. Studies that use validated scoring systems for outcomes, which are clear and reproducible, should be modeled after (Whittemore et al., 2016). Studies demonstrating specific mediators of change are also notable (Jaser et al., 2013). Further, there is a lack of economic data to support the use digital health interventions; future studies should include comprehensive economic evaluations of digital interventions (Badawy & Kuhns, 2016; Iribarren et al., 2017). Finally, there was significant variability in the types of medical and patient-reported outcomes in the

studies identified in this review, with notable gaps in critical outcomes like suicide prevention. While some studies show promise in using technology to decrease suicidal ideation and attempts in adolescents, more research is needed on the usage of peer support in these interventions (Forte et al., 2021).

Given the rapid adoption of telehealth and virtual communication due to the COVID-19 pandemic, there will likely be greater interest in and research involving virtual peer support interventions for adolescents with chronic disease. The COVID-19 pandemic has brought psychosocial challenges for youth with chronic disease, including reduced physical and psychosocial support from peers and healthcare providers, which may be addressed through digital support (Serlachius et al., 2020). The pandemic rapidly increased the use of telehealth and other digital interventions in pediatric care (Badawy & Radovic 2020). More research is needed to understand the cost-effectiveness of telemedicine and other digital health approaches, as well as their impact on quality of care (Badawy & Radovic 2020).

A major challenge for future research and clinical applications of digital interventions is how rapidly technology and the preferences of adolescents can change. The results of the intervention by Gonzalez-Morkos et al. (2014) showed that changing an intervention from in-person to telehealth due to the H1N1 influenza epidemic in 2010 resulted in lower satisfaction among those who changed to virtual versus those had started with a virtual intervention only. This underscores the need for user-centered design and working with adolescent “end users” to “codesign” an intervention to meet their needs and expectations (Elsbernd et al., 2018). Involving patients in the development process is critical to their engagement with the digital health platform (Badawy et al., 2017b). Engagement can be conceptualized as both a subjective experience in interacting with the technology and as usage behaviors (Perski et al., 2017); it is important to seek the input of adolescents early in the process of development to ensure short- and long-term engagement with the tool (Badawy et al., 2016; Badawy et al., 2017a, 2017b). It will also be important to frequently re-evaluate the state of the literature to remain up to date. Ongoing work is needed to evaluate the usefulness of rapidly changing technologies and identify who benefits most from different interventions.

Conclusion

The state of the literature regarding technology-based peer support interventions for adolescents with chronic disease is currently in an early phase, with overall low quality of study designs. However, the growing number of interventions being evaluated and the consistently positive feasibility data point to the promise of these interventions. This review

identified websites with discussion forums as the most commonly used technology, followed by chat messaging and then videoconferencing. Early efficacy data suggest social support is improved by these interventions, but future studies of adequately powered randomized control trials with validated outcome measures are needed. Finally, the COVID-19 pandemic underscores the importance of evaluating virtual interventions for adolescents with chronic disease to support patients no matter their geographic location.

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Declarations

Conflict of interest Patricia Berkanish, Samuel Pan, Adrienne Viola, Quinn Rademaker and Katie A. Devine declare that they have no conflict of interest.

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