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Leveraging digital technology for social connectedness among adults with chronic conditions: A systematic review

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Abstract

Purpose: To review the evidence about the impact of digital technology on social connectedness among adults with one or more chronic health conditions.

Methods: PubMed, Embase, Social Sciences, CINAHL, and Compendex were systematically searched for full-text, peer-reviewed empirical evidence published between 2012 and 2023 and reported using the PRISMA flow diagram. Articles were critically appraised applying the Joanna Briggs Institute checklists. Specific data were extracted based on the framework for social identity and technology approaches for health outcomes and then analyzed and synthesized.

Results: Thirty-four studies met study criteria. Evidence showed heterogeneity among research methodology, chronic health conditions, digital technology, and health outcomes. Technology use was influenced by factors such as usability, anonymity, availability, and control. More advanced digital technologies require higher digital literacy and improved accessibility features/modifications. Social support was the most measured aspect of social connectedness. The emotional and informational forms of social support were most reported; instrumental support was the least likely to be delivered. Self-efficacy for using technology was considered in seven articles. Sixteen articles reported health outcomes: 31.2% ($n=5$) described mental health outcomes only, 18.8% ($n=3$) reported physical health outcomes only, 31.2% ($n=5$) detailed both physical and mental health outcomes, whereas 18.8% ($n=3$) denoted well-being or quality-of-life outcomes. Most often, health outcomes were positive, with negative outcomes for selected groups also noted.

Conclusion: Leveraging digital technology to promote social connectedness has the potential to affect positive health outcomes. Further research is needed to better understand the social integration of technology among populations with different contexts and chronic health conditions to enhance and tailor digital interventions.

Keywords

Digital < general, digital health < general, chronic < disease, social connectedness, technology < general, systematic reviews < studies

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Social connectedness is an innate psychological need for belonging to an individual and/or a group.[1] Social connectedness refers to the perceived quality of a social interaction rather than the number of social interactions.[2] Robust evidence has emerged over the last four decades, and especially during the COVID-19 pandemic, that lack of social connectedness is associated with a significantly increased risk of premature mortality independent of age and

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chronic condition.[3,4] Although social connectedness and its related components (such as social support) have been studied extensively in in-person human interactions, little is known about how digital technology is being used to promote social connectedness and positive health outcomes for individuals with at least one chronic health condition among all adults aged >18 years. Systematic reviews have focused on either teens with chronic health conditions or older adults in general and how these populations use social support.[4–6] In the current systematic review, we addressed this gap by exploring how digital technology has been leveraged to promote social connection among individuals living with chronic health conditions. We evaluated the recent and limited body of research on digital interventions designed to support social connectivity among this population. Research and practice considerations regarding the feasibility of using digital technology to improve the quality of social interactions and health outcomes for individuals with chronic conditions are discussed.

Background

Chronic health conditions may cause debilitating physical symptoms that limit physical ability to leave one's home, as well as distressing psychological and social effects. In 2018, 51.8% of US adults were diagnosed with one chronic health condition, and 27.2% had two or more chronic health conditions.[7] Individuals with chronic health conditions are at a greater risk of social isolation and loneliness due to a compromised sense of self and stigma-related stress.[8]

Although the significant role of social connectedness on positive health outcomes in the context of chronic disease management has been established,[9,10] little is known about how meaningful social connectedness is achieved in a virtual context for individuals with chronic conditions. Prior studies have focused on the use of telemedicine to improve patient access, service delivery, and clinical outcomes within a variety of sub-specialties and across multiple chronic conditions and age categories.[11] In addition, prior research has examined the effects of digital technology on social isolation in older adults,[12] and social media use for health purposes by people with chronic conditions.[13]

In today's digital age, communication technologies, such as the internet, can contribute to social connectedness for individuals. As such, internet communities called social networking sites have emerged, and online social support groups have rapidly expanded.[14] Internet communities show potential for social connectedness because of certain benefits, such as anonymity, control, visibility, and availability.[15]

Generally, these perceived benefits of social networking offer the comfort, assistance, and assurances of engaging in social relationships with little personal risk of embarrassing or compromising situations.[16] Additionally, digital technology enables asynchronous access to a larger group of individuals who may share similar life experiences or interests. For example, an individual with a specific chronic health condition may find digital based interventions effective and convenient for identifying others with similar health issues to share and receive supportive care and connection.[1] For this systematic review, digital-based interventions are designed to either affect health behavior or promote a health outcome among adults with one or more chronic health conditions through the use of an electronic device (e.g. smart phone) or system (e.g. social media).[17] Other examples of these technologies included telephones, short messaging services, app usage and computer platforms (e.g. Facebook, WeChat) and websites (e.g. Thrive with Me, ONESELF), videoconferencing systems, virtual reality, and robotics (see Appendix A).

Recently, researchers have become increasingly interested in computer-mediated support resources for individuals with chronic health conditions, as approximately 70% of US adults search the internet for information about a health issue.[7] Thus, the purpose of this systematic review was to review and synthesize the evidence about the impact of digital technology on social connectedness among adults with one or more chronic health conditions.

Guiding frameworks

As we aimed to understand the use and benefit of digital technology as it relates to social connectedness among adults with one or more chronic health conditions, we combined and adapted the social identity approach to health (SIAH)[18] with the technology acceptance model (TAM) to include relevant concepts[19] (Figure 1).

According to SIAH, self-identity impacts how we socially connect to each other. As such, we desire connections to those whom we can socially integrate for support of shared knowledge, attitudes, beliefs, and behaviors. Social support, a critical component of social connectedness, may be frequently enacted or received and is deemed most valuable because it is required during need-based situations. When social support is needed and perceived, one's self-efficacy increases, such that there is more self-confidence to engage in purpose-driven behaviors (e.g. self-management). Perceived social support also results in an increased intention to help others who have experienced similar situations (i.e. voluntary reciprocal helping behaviors).[18]

The TAM is an information systems theory that frames the major predictors of technology acceptance and use. The type of technology or "delivery mechanism" was explored alongside social integration based on the hypothesis that seeking technology is (1) a means to social connectedness and (2) involves associated characteristics that build social connections. The double arrow between delivery mechanism and social integration was used to suggest covariance between these actions. Acceptance and ultimate use of digital technology depends on its perceived ease of use, its perceived usefulness toward accomplishing a chosen purpose, one's attitude or evaluative judgment

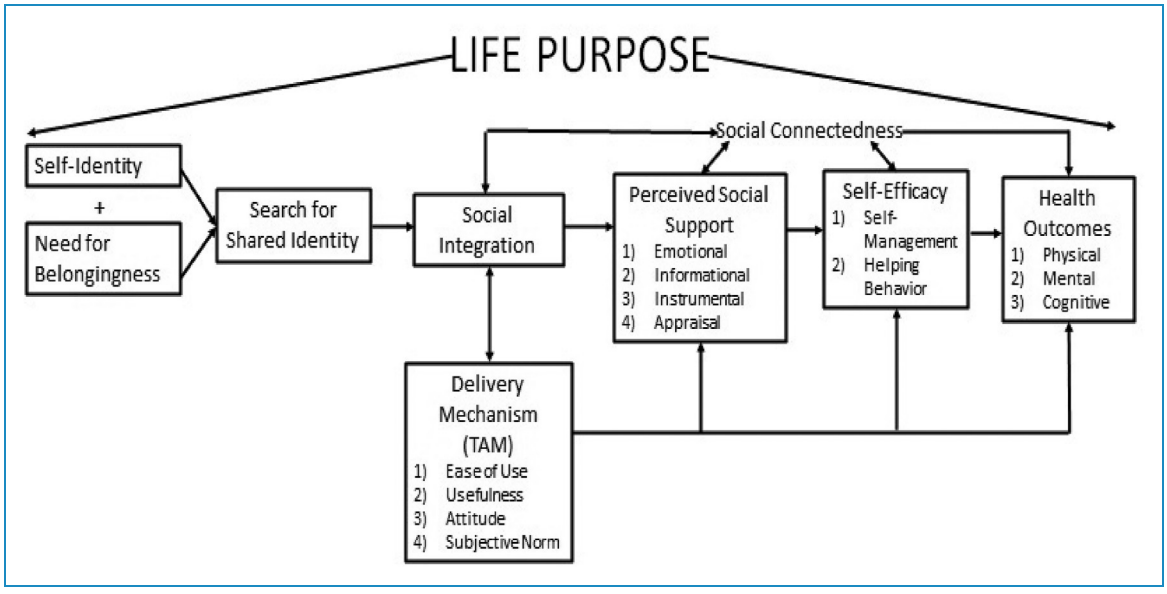

Figure 1. Adapted framework for social identity and technology use approaches to health outcomes.[18,19]

about technology in general, and subjective or cultural norms regarding acceptance and use of technology.[19]

Methods

The research question guiding this systematic review was "Does digital technology improve social connectedness among adults with one or more chronic health conditions?" Inclusion criteria included full-text peer-reviewed articles of empirical evidence available in English and published from 2012 to 2023. The years 2012–2023 were chosen to capture the most recent evidence (over the last 10 years), and because of the rapidly changing digital landscape. The research team systematically searched the literature again prior to submission to capture any recently published articles, thus the year 2023 was included as an end date. Exclusion criteria were research articles targeting patient populations under 18 years and animals. Articles that focused solely on caregivers' technology usage without also including patients with chronic conditions were also excluded. The systematic review did not require prior ethics approval, as the sample includes peer-reviewed, published research articles.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (see Appendix B) and flow diagram were used to guide the protocol, document the search process, and report the final articles selected. All items on the PRISMA checklist were addressed. It is important to note that a formal protocol of this systematic review was not prepared for registration, however, the key documents detailing our protocol have been included as appendices (see Appendices A and B). Quality assessments of the selected articles were completed using the Joanna Briggs Institute (JBI) checklists.[20]

Search strategy

Using major concepts (i.e. digital technology, social connectedness, and chronic health conditions) from the research question, a table was created listing medical subject headings (i.e. MeSH) and title and abstract terms (i.e. TIAB) of each concept (see Appendix A). A search strategy was created by connecting all terms with Boolean operators. Using this search strategy and adapting based on specific search requirements of each database, we systematically searched five electronic databases: PubMed, Embase, Social Sciences, CINAHL, and Compendex in April 2022 and March 2023. All articles were downloaded into Excel.

Selection process

Phase I: After duplicate articles were removed, our team of seven researchers split into three groups, and each group reviewed one-third of the articles based on title and abstract only. We met as a team to discuss and decide on any articles when there was uncertainty if the articles met selection criteria. If there was any doubt or a consensus was unable to be reached, we kept the article for the next round of review. To increase rigor and acquaint team members with all articles, the groups switched articles and once again reviewed based on title and abstract.

Phase II: New groups of three were formed to read the full text of their assigned articles and discussed each article based on the presence of all major components and the inclusion and exclusion criteria. If a group had a concern, it was discussed with the entire team for consensus. If undecided, the article was kept for the next round of review.

Phase III: The primary author (PJW) sorted and assigned articles by research design to the groups. Each group read

the full text of their assigned articles and assessed methodological quality using the JBI checklist. JBI offers checklists based on the type of study (e.g. randomized controlled trial, cross-sectional, qualitative, etc.).[20] After group work, we all discussed results as a team. At this point, all researchers had read each article at least two times and discussed them in detail several times.

Phase IV: Several investigators searched their personal libraries and the bibliographies of published systematic reviews for articles that met inclusion/exclusion criteria. The team also searched for articles using Google Scholar. Three additional articles were incorporated into the sample, read by all, and assessed for quality.

Quality assessment

Systematic reviews incorporate a critical appraisal process of the research evidence. The purpose is to promote the inclusion of higher quality studies and findings. The JBI, an international research organization and global leader in evidence-based healthcare, was chosen because it offers checklists and rigorous processes for diverse forms of evidence. JBI recommends that articles for inclusion be appraised by two people, with a third person to resolve conflict or disputes.[20] Our team had two researchers assess each article, with five additional researchers to discuss concerns or discrepancies.

Data collection and synthesis

Each investigator was given a construct (i.e. social support, self-efficacy, etc.) from the guiding framework (see Figure 1) to gather results from all articles within the designated domain. The research team met several times to synthesize the results and construct the manuscript. The manuscript was iteratively reviewed and edited.

Results

A systematic search revealed 34 articles that included key terms and met the inclusion and exclusion criteria (Figure 2).

Articles included in the final search were compiled into a summary table for comparison. Information such as research design, technology, intended purpose, and study outcomes were included in the final summary table (Table 1).

All articles included in this systematic review met JBI criteria based on the questions for the specific research design of each article. Of the 34 studies, there were 17 different chronic health conditions featured, with cancer ($n = 8$) being the most frequent, followed by type 2 diabetes ($n = 3$). The other conditions are listed in Table 1 and include mental health conditions, chronic pain syndromes, diseases of organs (e.g. chronic kidney disease), and chronic intellectual and developmental conditions. Along

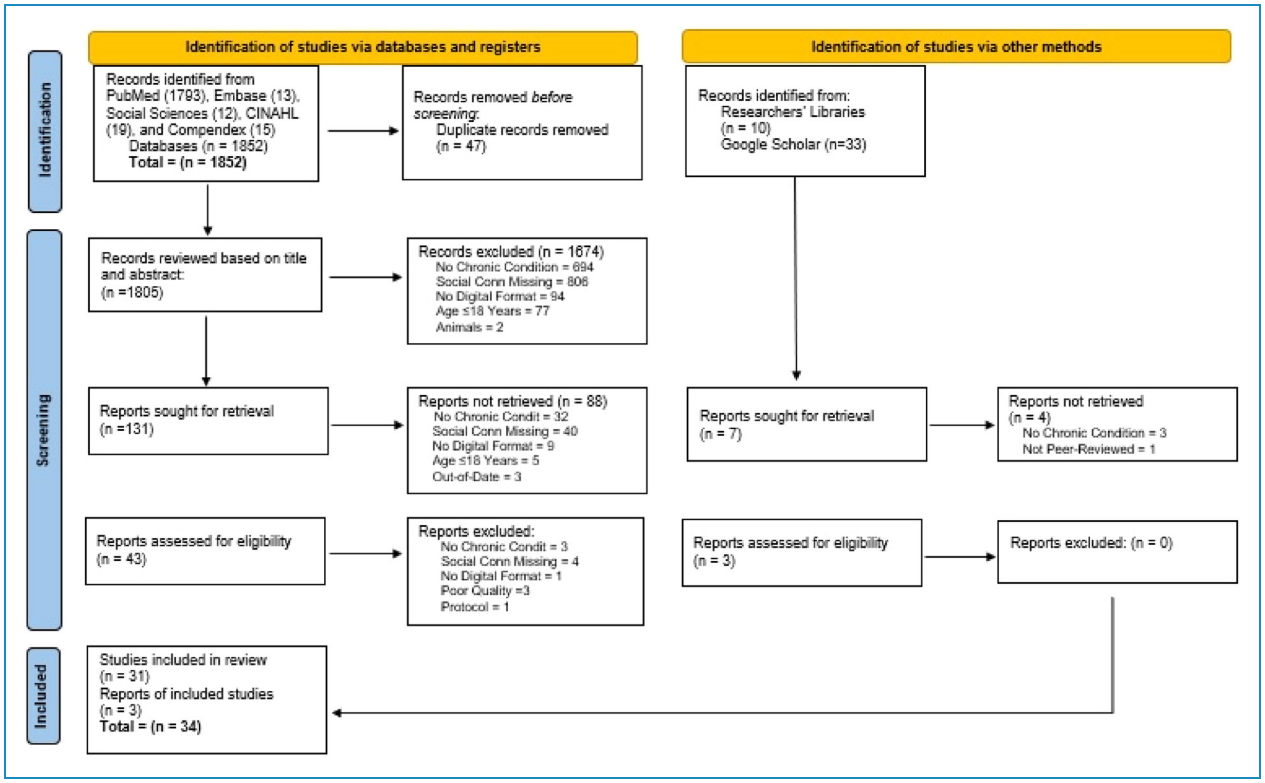

Figure 2. PRISMA flow diagram.

Table 1. Characteristics and JBI appraisal levels of the studies, as organized by interventional strategy.

Author	Year	Purpose	Study design	Chronic condition	Digital tech	Sample size	Age of sample	Outcomes	JBI appraisal
TO INCREASE HEALTH BEHAVIOR									
Richardson et al.[21]	2010	Measure impact of online community on average daily step count, motivation, and attrition	Randomized Controlled Trial	Obesity, Type 2 Diabetes, or CAD	Internet-mediated walking program with online community features	$n = 324$ (113/211)	Mean 52.0 (±11.4)	↑ emotional and information social support; ↑ engagement from those with low baseline social support; No impact on average daily step count; ↓ Attrition	1c
Fujioka et al.[22]	2012	Assess behavioral and mental changes of pregnant smokers who participated in an e-smoking cessation program during the first trimester	Nonrandomized One-Arm Controlled Trial	Tobacco Addiction	Cellphone: Internet: e-learning cessation program	$n = 48$ (0/48)	Mean 25.9 (±4.7)	High participation and cessation rate with ↑ self-efficacy	1d
Horvath et al.[23]	2013	Assess feasibility and acceptability of an online social support intervention to ↑ medication adherence	Randomized Controlled Trial	HIV	Computer: Interactive Website ("Thrive with Me")	$n = 123$ (123/0)	Mean 42.7 (±10.3)	Internet social support acceptable to men who are HIV+ and may ↑ medication adherence.	1c
Allam et al.[24]	2015	Assess effects of online social support and gamification to ↑ physical activity, empowerment, and condition-specific knowledge and ↓ health care utilization and medication overuse	5-Arm Parallel Randomized Controlled Trial (6 Months)	Rheumatoid Arthritis	Internet: Web-based including online social and informational support features and gamification ("ONESELF")	N = 155 (84/71)	57.9 (±11.0)	Gamification alone or with social support ↑physical activity, ↓ healthcare utilization, ↓ medication overuse	1c

(continued)

Table 1. Continued.

Author	Year	Purpose	Study design	Chronic condition	Digital tech	Sample size	Age of sample	Outcomes	JBI appraisal
Blackstock et al.[25]	2015	Assess perspectives of role and use of online groups to provide empowerment	Qualitative	HIV	Computer, mobile devices	$n = 27$ (0/27)		↑ use but limited by access and digital literacy. Trust essential to building online connection.	3e
Banbury et al.[26]	2017	Examine impact of weekly videoconference group meetings on participants' social networks	Mixed Methods (Social Network Analysis + Surveys + Interviews)	Random: Elderly from a Health Clinic	Video Conferencing	$n = 45$ (NR)	Mean 73.0 (±6.0)	↑ life engagement, ↑ self-management	2c
Johnston et al.[27]	2019	Evaluate the evidence-based relapse-prevention smartphone system (A-CHESS: Addiction Comprehensive Health Enhancement Support System) to ↑ treatment retention among women in an impoverished rural setting.	Quasi-Experimental with Posttest Only	Substance Use Disorder	Cell phone; Wi-Fi Connection	98 (0/98)	18.0–40.0	↑ treatment retention	2d
Young et al.[28]	2018	Determine feasibility of an online support intervention (HOPE) to ↓opioid misuse and overdose	12-week Randomized Controlled Trial	Chronic (non-cancer) Pain	Facebook private community pages	$n = 51$ (21/30)	Mean 43.5 (±14.6)	↑ online discussions about physical and mental health status, coping, pain management, and social support. No outcome measures reported.	1c
TO IMPROVE HEALTH OUTCOMES									
Travis et al.[29]	2010	Assess feasibility of a telephone-based, mutual peer support	Feasibility Study (12 Weeks)	Major Depressive Disorder	Telephone	$n = 54$ (34/20)		Intervention feasible and acceptable. Small significant ↓	1d

(continued)

Table 1. Continued.

Author	Year	Purpose	Study design	Chronic condition	Digital tech	Sample size	Age of sample	Outcomes	JBI appraisal
		intervention to ↓ depressive symptoms and ↑ quality of life						depressive symptoms, ↑functional ability	
Heisler et al.[30]	2013	Assess if NP-led goal setting sessions and weekly peer telephone calls would ↑ quality of life and ↓ hospitalization.	Randomized Controlled Trial	Heart Failure	Telephone	$n = 266$ (128/138)	Mean 69.0	No or minimal engagement with peer support program; no improved outcomes.	1c
Pereira[31]	2014	Assess use of Facebook with therapist as "friend" to ↑ treatment adherence	Randomized Controlled Trial	Treatment Resistant Major Depressive Disorder	Computer: Internet (Facebook)	$n = 57$ (NR)	18.0 −70.0	↓ depressive symptoms with Facebook use, even more with psychiatrist as "friend"	1c
Burner et al.[32]	2018	Assess feasibility of social support module integrated into an mHealth intervention to ↑ diabetes knowledge, self-efficacy, and subsequent disease management	13-Week Randomized Controlled Feasibility Trial	Diabetes	Telephone: Text Messaging	$n = 44$ (19/25)		Intervention feasible. ↑ glycemic control. No significant difference on social support from family or other clinical outcomes.	1d
Toija et al.[33]	2019	Assess effectiveness of peer support on health-related quality of life	Randomized Controlled Trial	Breast Cancer	Telephone	$n = 260$ (0/260)	Mean 60.0 (±10.5)	Marginal and transient effect on health-related quality of life	1c
Baldwin et al.[34]	2020	Assess efficacy of web-based program to ↑psychosocial and occupational functioning	Randomized Controlled Trial	Type 2 Diabetes	Computer: Web-based public health program ("myCompass")	$n = 723$ (286/437)	Mean 58.0 (±10.3)	↓ depressive symptoms and anxiety, ↑ self-management	1c

(continued)

Table 1. Continued.

Author	Year	Purpose	Study design	Chronic condition	Digital tech	Sample size	Age of sample	Outcomes	JBI appraisal
Marshall et al.[35]	2020	Assess feasibility of delivering group social support via a multi-user, virtual reality platform (EVA Park) and measure wellbeing, communication, social connectedness, and quality of life	6-month Randomized Controlled Trial	Aphasia s/p Stroke	Virtual Reality via Internet	$n = 34$ (17/17)	Mean 53.5 (48.0–71.0)	Feasible. ↑ mental well-being	1c
Welch et al.[36]	2020	Assess a social support tool to ↑participants' social network, thus ↑ health outcomes and quality of life to ↓ healthcare utilization and costs	Pilot Randomized Controlled Trial	COPD	"Generating Engagement in Network Support" (GENIE)– self-management support service and database	$n = 60$ (30/30)	Mean 70.5 (±7.2)	55% of participants ↑social network size and ↓anxiety levels.	1d
Yi et al.[37]	2020	Assess impact of a survivorship-focused Internet program, with the option to use social media and texting, on mood, stress, and healthcare	Randomized Controlled Trial	Cancer with Hematopoietic Cell Transplantation	Computer: Internet (INSPIRE); Cellphone: texting	$n = 945$ (488/457)	Mean 56.2 (±12.6)	Survivors with baseline limited support more likely to use INSPIRE program. Need strategies to reach younger male and African American HCT survivors.	1c
Yu et al.[38]	2020	Examine usage, patterns, endorsement, and association to clinical outcomes of WeChat-based mHealth program	Cross-Sectional	Schizophrenia	WeChat, social networking app in China	$n = 400$ (200/200)		Users younger, more educated, and more likely employed with fewer social connections. ↓ psychiatric symptoms and depression; ↑ functioning, recovery, and quality of life	4b

(continued)

Table 1. Continued.

Author	Year	Purpose	Study design	Chronic condition	Digital tech	Sample size	Age of sample	Outcomes	JBI appraisal
Ghanbari et al.[39]	2021	Assess satisfaction with mobile self-management app and online support group to ↓anxiety and ↑ self esteem	Randomized Controlled Trial (4 Weeks)	Breast Cancer	Cellphone: mobile self-management app and online group chat (WhatsApp)	$n = 82$ (0/82)	46.4 (±9.3)	↓anxiety scores, ↑ self-esteem scores	1c
TO IMPROVE SOCIAL CONNECTION									
Blakeman et al.[40]	2014	Explore perspectives of a telephone-based service to engage participants, ↑ social contacts, and link to community support and local health resources	Qualitative	Chronic Kidney Disease, Stage 3	Computer: Website Telephone	$n = 20$ (5/15)	Mean 68.9	Engagement dependent on timing and stage of life. Health problems (e.g. fatigue) a barrier to physical participation.	3e
Han et al.[41]	2014	Determine levels of engagement in social support groups among breast cancer survivors and what role types of engagement play in explaining psychosocial outcomes	Secondary Analysis	Breast Cancer	Computer: Internet: Social Support Groups	$n = 397$ (0/397)	Mean 50.8 (±8.9)	Socio-demographic characteristics, psychosocial factors, and digital literacy predict engagement. Lurkers have ↑ perceived functional well-being than posters.	3c
Merolli et al.[42]	2014	Explore what social media therapeutically affords people living with chronic pain who self-manage condition	Qualitative	Chronic Pain	Social Media	$n = 68$ (10/58)	18.0–60.0+	Social media afforded exploration, connection, and emotional catharsis of shared experience	3e

(continued)

Table 1. Continued.

Author	Year	Purpose	Study design	Chronic condition	Digital tech	Sample size	Age of sample	Outcomes	JBI appraisal
Owen et al.[43]	2015	Characterize levels of and factors for engagement (e.g. time spent, # and length of messages, etc.) in a multi-component Internet intervention designed for social networking	Randomized Controlled Trial (12 Weeks)	Cancer	Internet-health platform with guided modules, live weekly chat, discussion board, personal profiles, and webchat.	$n = 296$ (65/231)	Mean 54.0 (±10.8)	~80% engaged at beginning with steady decline over 12 wks; social networking used more often than structured education or facilitated discussion; previous social media users more engaged	1c
Namkoong et al.[44]	2017	Examine the effect of existing offline social support and family relationship perceptions on patients' use of online communication networks	Randomized Controlled Trial	Cancer	Computer: social support groups	$n = 243$ (NR)	Mean 51.1 (±9.2)	A negative correlation exists between offline perceived social support and use of online social support groups.	1c
Wise et al.[45]	2018	Assess effects of a narrative intervention with online resources and social networking on patients' well-being and explore intervention use and satisfaction	Randomized Controlled Trial	Cancer, Stage III or IV	Telephone and Internet (website with eHealth resources and social networking)	$n = 86$ (18/68)	Mean 57.0 (±8.8)	↑ engagement that declined over time. ↑ sharing. Social networking use low because most participants already used another social network. Those with shorter time perspective were "trimming" social contacts.	1c

(continued)

Table 1. Continued.

Author	Year	Purpose	Study design	Chronic condition	Digital tech	Sample size	Age of sample	Outcomes	JBI appraisal
Gavrila et al.[46]	2019	Examine role of an online community (Facebook) to impact peer support	Qualitative	Type 1 Diabetes	Internet: social media (Facebook)	$n = 21$ (12/9)		Participants reported receiving and giving technical, emotional, and informational social support	3e
Lepore et al.[47]	2019	Examine effect of digital literacy on engagement in and psychological benefits from an internet-based peer support group	Secondary Analysis of a Randomized Controlled Trial	Breast Cancer	Internet: support group with facilitated discussion and chat room	$n = 183$ (0/183)	29.0–65.0 (61% $\geq$ 52.0)	Low digital literacy associated with computer anxiety, leading to barriers in support group usage.	3c
des Bordes et al.[48]	2020	Assess participant engagement on a condition-specific online social support group	Single Arm Nonrandomized Controlled Trial	Rheumatoid Arthritis	Private social media Online Discussion Group (Facebook)	$n = 90$ (5/85)	Median 54.0 (24–84)	↑ social support, specifically information seeking and sharing and emotional; ↓ participation over time	1d
Valentine et al.[49]	2020	Explore engagement and experience with a long-term social media-based mental health intervention to ↑ social connectedness	Qualitative	1st Episode Psychosis	Computer: Customized Online Social Network ("Horyzon's")	$n = 12$ (5/7)	Mean 23.2 (19.0–28.0)	Themes: 1) shared identity, 2) social support, 3) upbeat environment, 4) barriers to use (social anxiety, paranoia, stigma, lack of autonomy, social protocol)	3e

(continued)

Table 1. Continued.

Author	Year	Purpose	Study design	Chronic condition	Digital tech	Sample size	Age of sample	Outcomes	JBI appraisal
Chen et al.[50]	2021	Explore online discussion posts for the impact of Covid-19 on daily life, reactions to it, information and technology use during, and social connectedness.	Qualitative	Frailty	Internet: online discussion forums	10 (3/7)	Mean 75.3 (±6.3)	Online websites used for information and social media (i.e. Facebook, Instagram) to educate others. Telephone, Internet, videoconferencing, and email for social connectedness.	3e
Corbett et al.[51]	2021	Describe virtual home assistant use and usefulness from the perspective of older adults and their support persons.	Mixed Methods with Dyads	Random: obesity, hypertension, type 2 diabetes, depression, atrial fibrillation, fibromyalgia, and stroke	Virtual Home Assistant (i.e. Amazon Alexa)	10 (1/9)	Mean 75.0	VHA used regularly over time for information, entertainment, or prompts.	2d
Lazard et al.[52]	2021	Explore perspectives of social support via social media among young adults with cancer	Qualitative	Cancer	Computer: Internet: social media; Cellphone: texting, apps	$n = 45$ (12/33)	Mean 31.0 (±5.6)	Digital tech used: internet social support groups (Facebook, Caring Bridge, Snapchat, TikTok, YouTube), web-based forums (Caring Bridge, Gryt Health, American Cancer Society), and video chat platforms (Zoom, Webex). Also, cellphone for texting and meeting apps (e.g. WhatsApp)	3e

(continued)

Table 1. Continued.

Author	Year	Purpose	Study design	Chronic condition	Digital tech	Sample size	Age of sample	Outcomes	JBI appraisal
Paul et al.[53]	2021	Explore what technologies individuals with intellectual disabilities use and how the technologies ↑ social connectedness	Qualitative	Intellectual and Developmental Disabilities	Wireless Technology	$n = 27$ (7/20)	Mean 43.4 (±15.0)	Technology included cellphones (texting and calling), wearables, social media (Facebook, Instagram, messenger), digital assistants	3e
Tan et al.[54]	2021	Identify predictors of negative experiences among people with obsessive-compulsive and related disorders who use social media peer support groups	Convergent Parallel Mixed Methods	Obsessive Compulsive and Related Disorders	Internet: social media peer support groups (Facebook and Reddit)	$n = 90$ (6/84)	Mean 27.0 (±5.8)	Treatment barriers and lower levels offline support predicted negative experiences using social media. Predictors of negative experiences: (1) confronting content; (2) misinformation causing confusion; (3) preoccupation with symptoms because time reading about them; (4) social comparison; and (5) hopelessness about recovery prospects.	2d

JBI level of evidence: 1 = Experimental Designs, 2 = Quasi-experimental Designs, 3 = Observational-Analytic Designs, 4 = Observational-Descriptive Studies, 5 = Expert Opinion and Bench Research.[20]

with the heterogeneity of chronic health conditions, there was variability among study designs, with most being either qualitative ($n = 13$) or randomized controlled trials ($n = 12$). Sample sizes ranged from 12 to 1065, with the smallest sample sizes among populations with chronic conditions such as psychosis and intellectual disability and the largest sample sizes among populations with common chronic physical health conditions (e.g. diabetes, cancer). Most of the studies ($n = 23$) included both males and females, whereas eight studies involved either sex-specific chronic health conditions, such as breast cancer among women or sex-specific concerns such as substance abuse among new mothers. A few studies ($n = 3$) did not report sex as a demographic variable. The overall mean age of participants in 25 studies reporting this demographic was 48.3 years. In all studies, digital technologies were assigned as a component of an intervention and included hardware (e.g. computers, wearables, telephones) or software (e.g. Facebook, customized apps) and/or accessibility features (e.g. Siri).

Self and shared identity

All articles included a digital intervention focused on social connections among individuals with a similar or shared identity, thus incorporating peer support. Participants in qualitative studies also emphasized the need to connect with others with a shared identity.

> "…it provided someone who had experience with depression … and someone to talk to, other than family and friends, that can relate …." (p. 5)[29]

> " … the ability to meet someone who knows exactly what I'm going through …." (p. 5)[29]

In many articles ($n = 19$), researchers elaborated that participants preferred online social support where they were able to connect with people through shared experiences. Participants expressed that they could relate to others because they felt heard, understood, and supported. Shared experiences included the physical or mental challenges experienced due to their chronic condition, along with social concerns and frustrations about the negative impact of their condition on their life domains. Sharing these experiences added value and meaning to virtual spaces and increased participants' sense of social connectedness:

> "It's like … war veterans … where you have all the gatherings of people who have been through wars and they don't necessarily know each other personally, but they've all got that common war experience. And they can relate to each other, and they know what they've been through." (p. 5)[49]

> "I connected to them a lot more easier than I would with others … I felt like I was in a more calm relaxed space connecting with them …." (p. 6)[49]

Richardson et al. reported that people with low baseline social support sought other people with similar experiences and context to receive emotional and informational social support.[21] In a study among people with psychosis, several participants described "knowing" connections without a direct social relationship. The participants felt validated after sharing experiences:

> "It helped sort of reinforce that some of my experiences and feelings are normal …." (p. 6)[49]

Social integration

Social integration is the point at which adults with ≥1 chronic condition incorporate digital technology to socially connect with others who share similar identities. Thus, digital technology was used as a strategy by which adults with one or more chronic health conditions could expand social connection in a meaningful manner.

Digital technology used for social integration in this sample of articles included telephones/smartphones, computers, iPads, and videoconferencing technology. Large social media platforms such as Facebook, Instagram, YouTube, Skype, and TikTok were used for social networking in 15 studies, with Facebook ($n = 6$) being the most frequently used. Customized digital applications were featured in eight of the studies. The use of telephones and smartphones were identified in nine ($n = 9$) studies. Telephones/cellphones enabled social integration through

Table 2. Number of times social support domains appear in the articles.

Social support domains[56]	Definition	Number of articles (*n*, %)	Possibly included could not verify (*n*, %)
Emotional	Empathetic listening	33, 94.3%	0, 0.0%
Informational	Facts, anecdotal evidence, and advice	34, 97.1%	0, 0.0%
Instrumental	Tangible goods	10, 28.6%	2, 6.3%
Appraisal	Appraisal and constructive feedback	30, 85.7%	1, 3.1%

calls, texts, digital applications, and social media (with internet capability features).

Usability and usefulness

In this systematic review, six studies reported on usability (or ease of use), six studies reported on the usefulness of the digital technology, six studies discussed the user's attitude about the technology, and three studies accounted for subjective norms. Other features of digital technology that promoted its uptake included anonymity and unrestricted time of use.

> " … appreciate the anonymity of the system … it's easier to be open and honest …. You don't feel afraid of judgement, and you don't have to censor yourself." (p. 5)[29]

> "I liked being able to call whenever I needed some help." (p. 5)[29]

> "Social network sites allow me to interact with others on my own terms." (p. 9)[42]

The rapid and continuous growth of digital technology requires individuals to have certain skills and competencies (i.e. digital literacy) to use digital technology and navigate digital environments.[55] Digital literacy requires skills development, as it is not an innate ability. Barriers to computer use, such as computer anxiety and distress, were associated with low digital literacy.[47] Low digital literacy was found among certain population groups, such as those with intellectual and developmental disabilities.[53]

Social support

Theoretically, social connectedness draws from social capital (the network of social relationships). These resources include perceived social support from different domains: informational, emotional, appraisal, and instrumental.[1] Social support was the most measured aspect of social connectedness (Table 2).

Most of the articles ($n = 25$; 71.4%) included three domains of social support. All four domains of social support were included in six of the articles (17.1%). Two articles only included two domains (8.6%): Fujioka et al. (information and appraisal social support)[22] and Baldwin et al. (emotional and informational social support).[34] Toija et al.'s study only included emotional support (3.1%).[33] Informational, emotional, and appraisal support were each noted as being provided in over 93% of the studies. Instrumental support was the least common type of support offered. However, the components of the intervention or participants' reports of the types of social support they received were sometimes difficult to distinguish.[33,36,39,44]

Our definition of instrumental support also included the receipt of tangible goods or services after research completion. For example, there were situations where the participants were allowed to keep the smart watch or device (i.e. smart speaker) after the study concluded. A few of the researchers did not indicate whether participants had access to the digital support intervention (i.e. tangible goods/services received) after study completions thus provision of instrumental support could not be determined. Nearly all studies in which instrumental support was provided were intervention studies, and the instrumental support was nearly always in the form of provided tangible goods (e.g. exercise equipment, personalized list of community resources) and not active hands-on assistance with self-management or assistance with activities of daily living or instrumental activities of daily living.

Non-interventional designs were used in six studies (18.8%). The purposes of those studies were to gather information from specific users about which online platforms were accessed for social support and participants' perceptions of the quality and types of social support received.

Perceived positive versus negative support

When digital social support interventions were evaluated by participants, negative and positive experiences were reported in seven studies.[23,42,47,49,52–54] Negative experiences included: (1) exposure to negative attitudes by other group participants[23]; (2) concern about how others would use personal health information shared in online groups[42]; and (3) fear of being stalked, a decrease in human connections, and interaction with false personas through social media.[53] Participants who used a smart speaker noted concerns about the lack of health information and the accuracy of health information.[51] In Valentine et al.'s study, researchers found that social anxiety, paranoia, internalized stigma, lack of autonomy, and social protocol confusion exacerbated psychotic symptoms for young people with first episode psychosis when chatting with each other in an online group.[49] In another study focused on online social support for young people diagnosed with cancer, hearing about other group members' declining health or the death of web-based friends negatively impacted the hope of other users.[52] Also, reported in that same study was the uncertainty regarding the truthfulness of health information shared, and the heavy burden of reliving and recounting painful experiences of other group users. Regarding participant burden, one participant stated:

> "I was a mentor for a couple people, and I actually had to pull away because I kept reliving what I went through every time they were going through their next step, and it just, kind of pulled on my heartstrings. It would just

bother me when I heard someone had a worse-case scenario than I did." (p. 15)[52]

In Tan et al.'s study, contributing factors toward participants' negative experiences included: (1) confronting content; (2) misinformation; (3) preoccupation with symptoms; (4) social comparison; and (5) hopelessness about recovery prospects for individuals diagnosed with obsessive compulsive and related disorders.[54] Lastly, digital literacy was negatively correlated with distress before and after online chats during the social support intervention for breast cancer survivors in an internet-based support group.[47]

Self-efficacy

Self-efficacy was described as the perceived confidence individuals have when performing specific behaviors. Within the reviewed studies, only a few ($n = 7$) discussed self-efficacy. Two studies ($n = 2$) measured self-efficacy: one study ($n = 1$) with no significant changes and one study ($n = 1$) with a non-significant positive change.[32,34] However, the results of one study indicated that the intervention used was effective in developing self-efficacy.[22] Three studies measured empowerment and adherence as domains of self-efficacy.[23–25] However, many articles ($n = 21$) did not mention self-efficacy.

According to Haslam et al., the original authors of the social identify and health outcomes framework, increased self-efficacy leads to improved self-management of one's chronic health condition and increased desire to help others (i.e. helping behaviors).[18] Self-management was included as a measure in only six studies ($n = 6$). In one article ($n = 1$), researchers discussed an intervention which included a feedback component.[27] This component was framed by underpinnings of the self-determination-theory, which proposes that meeting a person's relatedness needs will improve adaptive functioning.[57] Enhancing a person's adaptive functioning may help build self-efficacy and, thus, improve self-management. Other ways of measuring self-management in the articles were through a social functioning survey, participant interviews, and content analysis of community discussions.[26,28,34] However, most studies ($n = 21$) did not include a self-management measure.

Helping behaviors were not identified directly in any article; however, helping behaviors were discussed in the articles as applicable to participants after social integration had occurred. For example, des Bordes et al. recognized that providing informational and emotional support was as important as receiving those types of social support.[48] As people become more confident with their identities and knowledge, they were willing to share their knowledge and experiences with other people with similar experiences.

"I feel valued sharing my resources with others." (p. 9)[42]

"I wanted to support them …. Actually gave them my experience …." (p. 6)[49]

"I focus on sharing what knowledge or information I have …, this mitigates the constant feeling of failure that comes along with ill health and the inability to be more active." (p. 9)[42]

Health outcomes

Out of the 34 studies included in this systematic review, 52.9% ($n = 18$) did not have a health outcome measure, whereas 47.1% ($n = 16$) did have a health outcome measure. In terms of the type of health outcomes, 18.8% ($n = 3$) were physical health outcomes only, 31.3% ($n = 5$) were mental health outcomes only, 18.8% ($n = 3$) were well-being or quality of life, and 31.3% ($n = 5$) were both physical and mental health outcomes. Regarding physical outcomes, Fujioka et al. measured carbon monoxide exhalation levels,[22] Owen et al. measured fatigue,[43] and Richardson et al. measured walking distance.[21] Regarding mental health outcomes, 80% ($n = 4$) measured anxiety levels as one of the dependent variables and 40% ($n = 2$) measured levels of depressive symptoms. Regarding well-being and/or quality of life, Han et al. measured functional well-being,[41] Heisler et al. measured heart failure quality of life,[30] and Toija et al. measured quality of life.[33] Among studies that included both physical and mental health outcome measures, 60% ($n = 3$) had depressive symptom measures and another 60% ($n = 3$) included quality of life measures.

The social connectedness components of the digital interventions and the resultant impact on health outcomes varied. Most researchers who measured health outcomes reported positive results (56.3%, $n = 9$) (e.g. decreased depressive symptoms, improved glycemic control). However, 18.8% ($n = 3$) reported negative results (e.g. increased anxiety, confusion due to misinformation), with 12.5% ($n = 2$) finding results that trended toward positive results but didn't reach statistical significance, and another 12.5% ($n = 2$) who found no statistically significant results. The variable that was most measured and had positive outcomes within these studies was depressive symptoms at 55.5% ($n = 5$). Other outcomes included: reductions in anxiety levels, other psychiatric symptoms, diabetes symptoms, and carbon monoxide exhalation levels, and improvements in functional well-being, physical health, quality of life, well-being, and psychological health.[21,22,29,34,38,39,41,45]

Discussion

The purpose of this systematic review was to evaluate the use of digital technology to influence social connectedness among adults with one or more chronic health

conditions. A growing body of evidence demonstrates the criticality of social connectedness on health outcomes.[18,58,59] Physical distancing imposed by the COVID-19 pandemic negatively impacted in-person social connectedness creating an exponential surge in digitalization. This study builds on prior research on social connectedness, digital technology usage and innovation by examining the intersectionality of digital technology to social connectedness (e.g. social support) and its impact on reported health outcomes for individuals with chronic health conditions within a virtual context. This area has been majorly underexplored in prior literature.

Most participants reported ease of use and increased satisfaction with digital technology because it eliminated geographic barriers, especially for individuals with mobility impairment, and times constraints for social connectedness. Anonymity features commonly found in digital applications and websites were perceived as providing safety from invasion of privacy, thereby increasing acceptance. The use of passwords on social networks increased the level of security and privacy, allowing for increased comfort in sharing personal thoughts and information. In addition, budding research shows a favorable projection for cost effectiveness and scalability of clinical interventions, although further research using standardized evaluative approaches is needed to determine cost-effectiveness, costs, and health outcomes.[60]

Negative aspects of digital technology use were the access to technology due to costs, internet availability, and/or physical limitations which impacted the accessibility of digital social support for some populations. Whereas social networks and video conferencing became a norm, individuals with low digital literacy were challenged and experienced greater social isolation and loneliness.[61] Low digital literacy is a consequence of social and economic inequalities that result in a limited ability or inability to effectively use and access digital technologies.[62] Thus, it remains critical to address the role of digital literacy and evaluate the potential efficacy of digital technology to impact social connectedness, including both positive and negative attributes and outcomes. However, overall, the attitude toward the use of digital technology was positive.

Our findings were consistent with the "helper effect,"[63] a principle that states people use the wisdom gained through living with a problem to help others with the same or similar problem, and in return their own recovery is strengthened. Selected articles that addressed the helper effect found increased social connectedness, a commitment to personal contribution, life satisfaction, improved wellbeing, and a higher life meaning when helping others.

Social support is often conceptually linked to social connectedness. Emotional, informational, and appraisal support were commonly provided through digital technology whereas instrumental support was apparent. The limited delivery of instrumental support through digital technology is not surprising because the digital platforms were primarily information and communication technologies (mobile phones, smartphones, computers, laptops, and iPads). Further, while we included the receipt of goods or services in the domain of digital support, instrumental support is more commonly associated with assisting someone to perform activities of daily living, which would be more challenging to provide with information and communication types of technology. However, apps such as medication reminders, physical activity tracking, or symptom monitoring are commonly used with information and communication digital technology platforms and would be considered instrumental support.[64] While research on those types of apps, which could be considered instrumental support, is fairly common,[65–67] studies that included digital self-management interventions were rarely identified in our search. Unexpectantly, and although included in the search strategy (see Appendix A), the research identified in this systematic review did not generate studies involving robotic platforms, which have the potential to promote social connectedness and to provide instrumental support for activities of daily living.[64] Based on the findings, one could argue that instrumental social support is not as highly emphasized as the informational, emotional, and appraisal domains. Further, instrumental support may not be captured by authors in key words for studies that involve social connectedness or social support.

Findings from studies in this review indicated positive aspects of each domain of social support, but a few of the studies, particularly those that sought qualitative feedback from participants, noted potential or actual negative aspects of digital social support. Mistrust and fear were especially noted when the study participants had stigmatizing health conditions (e.g. behavioral health conditions, substance use disorders) or were highly vulnerable (e.g. intellectual and developmental disabilities) populations. Mistrust issues were reported about whether information received was accurate, including the possibility of others in the group claiming to have expertise or credentials (e.g. being a physician) that they did not possess. Fears involved the potential misuse of shared information or lack of confidentiality of personal information and vulnerability to stalking or exploitation. Similarly, in a study involving older adults, Cotton et al. noted that older adults sometimes felt an increased risk when they shared self-identifying information on social media.[68] This "technophobia" is attributed to the digital divide, as older adults have been introduced to digital technology later in life than digital natives.[69]

Different aspects of technology and the characteristics of individual participants were also found to impact the usefulness of attaining social support using digital platforms.

Technologic glitches or complexity can reduce efficacy and engagement to attain social support. Individual participants' lack of technological literacy may present a barrier for some participants. Studies where users engaged with the app through automatic messaging or message algorithms sans engagement with other participants generally were less successful as compared to those where individuals could communicate directly with each other whether synchronously or asynchronously.[34,70] Finally, people need to feel that the social support intervention is relevant and applicable to their lived experience to engage in digital social support.[34,49,52]

The efficacy of peer support for social connection was mixed. Peer support success may depend on contextual health factors such as the specific health condition, time since diagnosis, prognosis, and severity. For example, peer support was ineffective in Toija et al.'s study due to the shock and anxiety of a recent diagnosis of breast cancer.[33] In Heisler et al.'s program for patients with heart failure, peer support was ineffective due to the patients' poor health and fatigue, reducing their desire to engage.[30] This finding is like that of a meta-analysis of psychosocial support interventions that revealed social support interventions were less effective when patients had relatively greater disease severity.[71] The use of peer leaders or role models facilitates more meaningful conversations among participants in online social support groups, as opposed to blindly entering an online social support group. All studies recommended further research with a focus on tailoring to the needs of the specific population. Depression and quality of life were a few of the most common variables measured in the examined articles. Other articles outside of the scope of this review also evaluated the associations between social connectedness and depression and quality of life outcomes and many found connectedness to be positively related to depression and quality of life.[72–77] Although there were three studies that found negative health outcomes associated with social connectedness in this systematic review,[33,49,54] there is little in the literature that supports this phenomenon. Findings from studies outside the scope of this review indicated that social connectedness had a positive correlation with health outcomes.[78–80] However, Yan who conducted a study with people who were obese, found that it is important for individuals to receive the right type of social support, or it may negatively impact their health outcomes (i.e. weight gain).[81]

Implications

Chronic health conditions present unique challenges that can impact the use of digital technology, thus a more nuanced guiding framework is needed to design new digital health interventions or tailor existing ones. In addition, a more standardized approach to designing and evaluating the impact of digital health interventions will allow for more meaningful comparison. Rapid digital expansion not only introduces new digital devices, but also new terms such as "digital innovation"[17] and "robotics" that should be more rapidly indexed and incorporated into future systematic reviews and meta-analyses. Even with current and established digital technology, some population groups have limited digital literacy (e.g. cognitive challenges or acute mental illness), thus there is need for global digital training with consideration for assistive devices. Lastly, system-level approaches are needed to help mitigate social and economic inequalities.

Strengths and limitations

Whereas we designed a comprehensive literature search and consulted additional sources such as author libraries, Google, and the references of published systematic reviews, there still exists the possibility that relevant studies could have been overlooked. However, the use of these additional resources helped validate our original search. Another limitation is the exclusion of terms for specific domains of social support. Additionally, our review team had seven members which strengthened the rigor when reviewing and discussing acceptable articles, quality assessment, and data extraction and analysis, although article quality was appraised under unblinded conditions. Lastly, based on the nature of this review and the focus of selected articles on certain chronic diseases, we were unable to determine a discernible collective difference in acceptability and usability of digital technology based on certain demographics (e.g. gender, ethnicity, etc.), although we highlighted significant demographic differences when reported in individual studies.

Conclusion

Evidence from most of the selected studies supports the positive impact of social connectedness through digital technology in providing greater access to social support for many individuals with chronic health problems. The studies varied in the types of digital technology, research methodology, population, and health outcomes. Heterogeneity existed within and among chronic health conditions. Factors that increased acceptance and usability by individuals with chronic conditions were the ease of use and usefulness of digital technology, the added protection of privacy, and the lack of geographic and time constraints. However, individuals who were chronically and severely mentally ill or those with intellectual developmental disorders were challenged by more complex digital technology. More advanced digital technologies require higher levels of digital literacy and cognitive functioning. Thus, there is a need for digital training and greater accessibility features (e.g. screen readers, assistive software) for individuals with chronic health conditions that involve sensory and/or cognitive deficits. Access could be

improved among those living in areas with inadequate internet connectivity. While leveraging digital technology to promote social connectedness has the potential to effect positive health outcomes, the unique contexts chronic conditions require a more nuanced theoretical approach. Further research is needed to better understand the social integration of technology among populations with different contexts and chronic health conditions to enhance and tailor digital interventions.

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Appendix A. *Search strategy for systematic review*

((“digital platform” or “digital technology” or “digital intervention” or “web based digital health” or “web based interventions” [MeSH Major Topic]) OR (“wearables” or “mobile applications” or “apps” or “internet based” or “tracker” or “computers” or “social media” or “social network*”)) OR (“Facebook” or “Twitter” or “Instagram” or “TikTok” or “email” or “text” or “virtual” or “virtual reality” or “augmented reality” or “artificial intelligence AND (meta-analysis [Filter] OR randomized controlled trial [Filter] OR systematic review [Filter])) AND (social connectedness” or “social connectivity” or “social connection” or “disengagement” or “loneliness” or “social cohesion” or “social isolation AND (meta-analysis [Filter] OR randomized controlled trial [Filter] OR systematic review [Filter]))) AND ((“chronic condition” or “chronic illness” or “disease” or “chronic disease” or “health conditions”) AND (meta-analysis [Filter] OR randomized controlled trial [Filter] OR systematic review [Filter]))

Appendix B

PRISMA Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Title, Title Page (p. 1)
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Abstract (p. 2)
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Intro & -Background
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Into (lines 56-58); Methods (lines 87-89)
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Methods (lines 89-97)
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Lines 113-114
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Lines 107-112; Figure 2; Appendix A
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Lines 116-137
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Ines 148-151
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Lines 148-150; Figure 1
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Lines 158-160

(continued)

Continued.

Section and Topic	Item #	Checklist item	Location where item is reported
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Lines 132-133; 138-146
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	N/A
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Lines 116-127
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Lines 148-151; 158-160
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Lines 158-160; Table 1
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Lines 158-160
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Lines 158-160
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	N/A
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Lines 138-146
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Lines 98-105

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Figure 2: PRISMA Flow Diagram
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Figure 2: PRISMA Flow Diagram
Study characteristics	17	Cite each included study and present its characteristics.	Table 1
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Table 1
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Lines 166-365; No effect estimates reported
Results of syntheses	20a	For each synthesis, briefly summarize the characteristics and risk of bias among contributing studies.	Table 1
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Lines 166-365
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Lines 166-365
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	N/A
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Lines 372-386; 393-396; 449-450; 461-463; 498-507
	23b	Discuss any limitations of the evidence included in the review.	Lines 475-480
	23c	Discuss any limitations of the review processes used.	Lines 477-480
	23d	Discuss implications of the results for practice, policy, and future research.	Throughout discussion; Lines 499-507

(continued)

Continued.

Section and Topic	Item #	Checklist item	Location where item is reported
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Methods, Lines 101-102
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Methods, Line 101-102
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Funding; Acknowledgements
Competing interests	26	Declare any competing interests of review authors.	Conflicting Interests
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Table 1; References; Appendix A

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71
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