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REVIEW

The influence of telehealth-based cancer rehabilitation interventions on disability: a systematic review

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Abstract

Purpose To characterize delivery features and explore effectiveness of telehealth-based cancer rehabilitation interventions that address disability in adult cancer survivors.

Methods A systematic review of electronic databases (CINAHL Plus, Cochrane Library: Database of Systematic Reviews, Embase, National Health Service's Health Technology Assessment, PubMed, Scopus, Web of Science) was conducted in December 2019 and updated in April 2021.

Results Searches identified 3,499 unique studies. Sixty-eight studies met inclusion criteria. There were 81 unique interventions across included studies. Interventions were primarily delivered post-treatment and lasted an average of 16.5 weeks ($SD = 13.1$). They were most frequently delivered using telephone calls (59%), administered delivered by nursing professionals (35%), and delivered in a one-on-one format (88%). Risk of bias of included studies was primarily moderate to high. Included studies captured 55 measures of disability. Only 54% of reported outcomes had data that allowed calculation of effect sizes ranging -3.58 to 15.66.

Conclusions The analyses suggest small effects of telehealth-based cancer interventions on disability, though the heterogeneity seen in the measurement of disability makes it hard to draw firm conclusions. Further research using more diverse samples, common measures of disability, and pragmatic study designs is needed to advance telehealth in cancer rehabilitation.

Implications for Cancer Survivors Telehealth-based cancer rehabilitation interventions have the potential to increase access to care designed to reduce disability across the cancer care continuum.

Keywords Telehealth · Cancer rehabilitation · Neoplasm · Function · Intervention · Disability

Introduction

Cancer-related disability is a pervasive consequence of the disease itself as well as oncology-directed treatment. For the purposes of this paper, cancer-related disability is defined as limitations associated with roles, routines, functional activities, or societal participation [1] or reductions in well-being. Nearly 55% of adult cancer survivors report restrictions in their ability to perform instrumental activities of daily living and 37% report restrictions in their ability to perform basic activities of daily living [2]. Survivors may also experience significant challenges in returning to employment due to functional limitations [3]. The negative influence of disability spans many different types of cancer [2] and can also affect a person's ability to tolerate cancer-related treatment and health-related quality of life [4].

The multidisciplinary field of cancer rehabilitation seeks to reduce disability and improve functioning among survivors [5]. Evidence from reviews supports the utilization of cancer rehabilitation interventions along the oncology care continuum [6–10]; however, rates of referral and participation are low [11, 12]. Although multifactorial, two factors are consistently implicated in low utilization [12, 13]. First, there are not enough rehabilitation specialists who have expertise in oncology [14]. Second, patients perceive they have limited time and energy to access rehabilitation

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services, particularly if they need to travel long distances to do so [15].

Telehealth-based cancer rehabilitation interventions may help to overcome patient-, provider-, and health system-related barriers which limit access to care [3, 16]. Telehealth is defined as "the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies, for the exchange of valid information for…treatment, and prevention of disease and injuries, [and] research and evaluation… in all the interests of advancing the health of individuals and their communities" [17, p. 9]. To develop robust cancer rehabilitation programs and train providers in the delivery of interventions, it is important to examine the characteristics and the effectiveness of existing telehealth-based interventions that address disability.

The purpose of this systematic review is to characterize intervention delivery features and evaluate the effectiveness of telehealth-based cancer rehabilitation interventions addressing disability among adult cancer survivors. The results of this systematic review will help to inform future telehealth-based cancer rehabilitation intervention development, testing, and implementation.

Methods

A study protocol was developed a priori using the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) checklist [18]. The protocol was registered on PROSPERO (CRD42020150791) prior to data collection. The 2020 PRISMA statement and checklist guided the manuscript development [19].

Information sources and search strategy

A biomedical librarian (AAL) developed a comprehensive search strategy in consultation with co-authors. The original search was run in December 2019 and updated in April 2021 using seven citation and abstract databases: CINAHL Plus (Ebscohost), Cochrane Library: Database of Systematic Reviews (Wiley & Sons), Embase (Elsevier), National Health Service's Health Technology Assessment (University of York), PubMed (US National Library of Medicine), Scopus (Elsevier), and Web of Science: Core Collection (Clarivate Analytics). Searches were limited to original research articles and systematic reviews published in English between 1994 and 2021. Keywords and controlled vocabularies (e.g., MeSH, EMTREE, CINAHL Subject Headings) were used to describe telehealth, rehabilitation, and cancer (see Supplementary File Table 1 for final search strategies used). EndNote X9.3.3 (Clarivate Analytics) was used to collect, manage, and identify duplicate citations. Individuals conducting the study selection process hand searched the bibliographies of literature reviews to identify relevant studies not captured in the search.

Study inclusion

We initially included studies evaluating cancer rehabilitation interventions that met the following criteria: (1) written in English, (2) had intervention goal(s) included prevention, reduction, or attenuation of decline in disability (i.e., goal of maintaining or improving function in daily roles and routines, preventing or reducing disability, maximizing participation, and/or improving a functional aspect of quality of life); (3) intervention delivered according to the World Health Organization definition of telehealth [17]; (4) included participants with a current or previous cancer diagnosis, (with or without their caregivers); and (5) measured disability, based on the definition by O'Young and colleagues [1], as a primary or secondary outcome. We operationalized the fifth criterion by saying the study needed to measure the impact on function and disability (e.g., social roles, activities of daily living, vocational roles, recreational roles) and/or use of a quality of life measurement tool that assesses ability to function as a component or aspect of quality of life [1]. The initial full text screening revealed a large number of relevant articles ($n = 132$). To ensure that we were synthesizing literature that addressed our specific research objectives, we added two additional inclusion criteria: (6) utilization of a randomized controlled trial design (to evaluate intervention effectiveness); and (7) inclusion of at least one synchronous interaction between participants and cancer rehabilitation professions (to more closely reflect current billable rehabilitation services).

Studies were excluded if they were as follows: (1) only pharmacological interventions; (2) interventions that addressed solely psychosocial outcomes (e.g., anxiety, depression, distress); (3) measured only impairment-based and symptom severity outcomes; (4) used only qualitative methodology; (5) were any of the following article types: reviews, white papers/editorials, qualitative studies, letters, commentaries, opinions papers, unpublished research; and (6) published prior to 1994.

Selection process

Prior to the study selection process, a pilot test of the study selection and data extraction process was completed with seven research team members (KDL, RB, LP, KC, GC, TM) on a sample set of four citations provided from the initial literature search. Adaptations were made to the data collection process based upon this pilot testing (e.g., addition of items to extract, ability to select more than one option, addition of fields). Reviewers (RB, KDL, JJ, LP, KC, MP, TM, GC, RE,

JS, AV, AMF, MF, TK, JB) were trained on data screening procedures through group and individual trainings. Team meetings were held twice during the screening process to discuss and clarify screening procedures.

Covidence (Veritas Health Innovation Ltd., Melbourne, Australia) was used to conduct the two-stage screening process. First, the titles and abstracts of articles were uploaded to Covidence and independently screened by a combination of two reviewers (RB, KDL, JJ, LP, KCW, MP, TM, TK, GC, RE, JS, AV, AMF, MF, JB). Disagreements regarding inclusion between reviewers were resolved through discussion between at least two of the senior project authors (KDL, RSB, LP). Next, the full text articles were independently screened by a combination of two reviewers (RB, KDL, JJ, LP, KCW, MP, TM, TK, GC, RE, JS, AV, AMF, MF, JB) using the same eligibility criteria. Disagreements between the two reviewers were resolved by a third reviewer who was blind to the initial reviewers' decisions.

Data collection process

A combination of two reviewers (RB, KDL, JJ, LP, KC, MP, TM, GC, RE, AMF, MF, BK, JB) independently extracted data from each included article. Extracted data were entered into a custom-designed Qualtrics survey (Qualtrics, Provo, UT). After completing double-data extraction, the pair of reviewers met to resolve any discrepancies. Final extracted data for each article were compiled into a Microsoft Excel spreadsheet to create a database of results. Each included article was assessed for risk of bias by one co-author (KDL, RB, JJ, LP, or RE) using the Cochrane Collaboration's Risk of Bias (ROB 2.0) tool [20]. To gain a better understanding of the breadth of intervention delivery and measurement tools used to examine functional disability, we made an a priori decision to not remove any studies with high risk of bias.

Data extraction and analysis

From each article, a combination of two of co-authors (RB, KDL, JJ, LP, KCW, MP, TM, GC, RE, JS, AV, AMF, MF, TK, JB, RE) extracted data pertaining to study designs, sample characteristics, relevant outcome measures (including raw means and standard deviations), and intervention characteristics (see Supplementary File Table 2 for a complete data dictionary). Study design characteristics included primary purpose of study (e.g., feasibility, efficacy or effectiveness, implementation) and primary endpoint. If the authors did not specify a primary endpoint, reviewers selected the assessment that was the closest to the completion of the intervention. Participant characteristics included the following: sex; type(s) of cancer diagnosis; age; race and/or ethnicity; and treatment phase. Telehealth intervention characteristics included the following: intervention name; brief experimental intervention(s) description(s); name and type of comparison or control intervention, discipline of interventionists, and intervention delivery features (format, duration, frequency, mode, dose, and length of session). When available, reviewers extracted raw means and standard deviations associated with baseline and post-intervention timepoints for all identified measures of disability.

We used descriptive statistics to summarize characteristics of study designs, participant characteristics, relevant outcome measures, and intervention characteristics. Most often, the unit of analysis was the study, for example, when describing the proportion of studies that used one delivery method versus multiple delivery methods or the average duration of each experimental intervention. Additionally, we used the value list for some variables as the unit of analysis, for example, to describe the proportion of telephone delivery included in the grand sum of all delivery methods reported across all studies.

Standardized effect sizes were used to determine the threshold of outcome clinical significance. For studies that reported raw group means and standard deviations at baseline and the study-specific primary endpoint, effect sizes (Cohen's *d*) were computed using standardized mean differences [21]. Between-group effect sizes were estimated by the differences between the intervention mean changes in functional disability in each intervention and control group divided by the pooled standard deviation (*SD*) at baseline [21]. If the study did not report a primary endpoint, the effect size of the follow-up closest to the post-intervention assessment was selected for comparison to reduce heterogeneity in data collection. Magnitude of effect size was categorized as negligible (<0.2), small (0.2–0.5), medium (0.5–0.8), or large (>0.8) [21]. Forest plots were developed to illustrate both the data for each specific study and the pooled estimates. A separate forest plot was presented for each subgroup of studies representing the most commonly included outcome measures. The mean difference and 95% confidence interval for each study in intervention and control groups were used to calculate the pooled mean difference. Q statistics with an I^2 index were used to assess heterogeneity between studies. An I^2 index of 50% or greater and a p value less than 0.1 were taken to indicate significant statistical heterogeneity [22]. In cases of statistical heterogeneity, a random effects model was applied. When there was no evidence of heterogeneity, the results of fixed effects models were presented. Statistical analyses were performed in R (Version 3.6.3) using the META and METASENS packages.

Results

Literature search and study selection

The literature and hand searches yielded 6,437 records of which 2,938 were duplicates and 3,499 were screened (Fig. 1). After the title and abstract screening was completed, 3,192 records were excluded and 307 proceeded to full text screening. One hundred thirty-two articles were included in the first-level of full-text review. The second level of full-text review specified articles that were randomized controlled trials, synchronously delivered, and administered by a rehabilitation professional. Of the 64 excluded during the second-level of full text screening, 26 were not randomized controlled trials, 21 did not deliver care synchronously, nine did not include a rehabilitation professional, and eight did not focus exclusively on adult cancer survivors. The final sample for analysis included 68 studies.

Risk of bias

A risk of bias assessment was completed for all included studies utilizing the Cochrane Collaboration's Risk of Bias (ROB 2.0) tool [20]. Studies were assessed across five domains describing bias associated with (1) randomization; (2) effects of intervention assignment; (3) missing outcome(s) data; (4) measurement of outcome; and (5) selection of reported results. Overall risk of bias was rated as low, some concerns, or high. These results are summarized in Supplementary Materials Table 3. Overall, included studies had the following risk of bias ratings: some concerns of bias ($n=29$, 43%), followed by high concern ($n=21$, 31%), and low risk of bias ($n=18$, 26%). Contributors to bias in studies rated as some concern and high concern ($n=50$) were

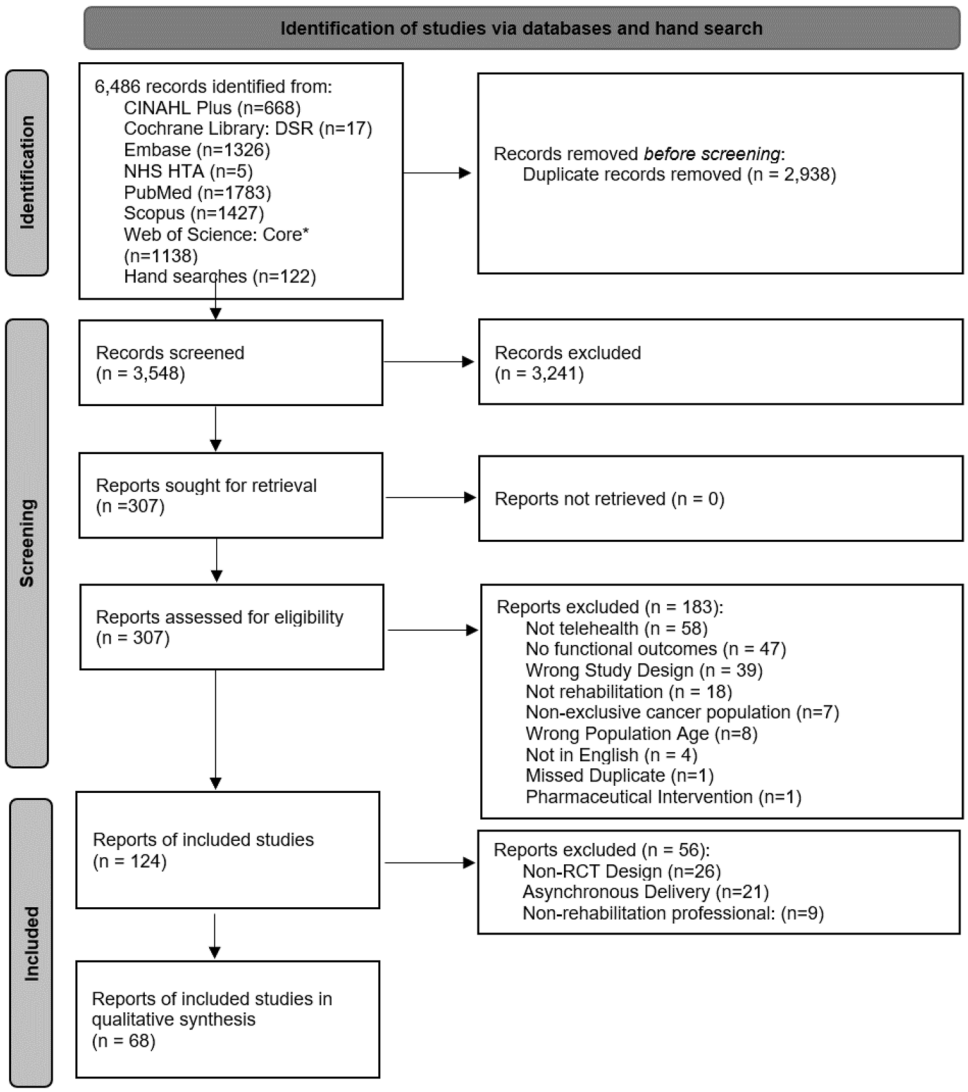

Fig. 1 PRISMA flow diagram

most commonly: bias in effects of intervention assignment ($n = 30$, 60%) and/or randomization ($n = 26$, 52%), followed by measurement of outcome ($n = 18$, 36%), selection of reported results ($n = 11$, 22%), and/or missing outcome data ($n = 8$, 16%).

Study sample and design

Table 1 describes the study samples. Across the 68 studies, sample sizes ranged from seventeen to 641 participants (mean: 154 individuals, *SD*: 160). Thirty studies (44%) exclusively enrolled females, ten studies (15%) enrolled only males, and the remaining studies ($n = 28$, 41%) enrolled both male and female survivors. Fifty studies (74%) enrolled participants of one cancer type. Within these studies, the three most prominent cancer types were breast ($n = 30$, 60%), prostate ($n = 8$, 16%), and colorectal ($n = 4$, 8%). Diagnoses ranged from one to eleven in studies that did not limit enrollment based on cancer type. Thirty-four of the 68 studies (50%) included participants that were post-primary treatment completion only whereas 23 studies (34%) enrolled patients during active cancer treatment. Only 5 studies (7%) included participants who were in varying phases across the cancer care continuum (e.g., participants currently receiving treatment and post-treatment completion). Of the 38 studies that reported race or ethnicity (56%), study samples were overwhelmingly White, non-Hispanic participants (mean: 81%, *SD*: 25).

The reported primary purpose of included study designs was to test efficacy or effectiveness ($n = 49$, 72%) followed by feasibility ($n = 16$, 24%), and implementation ($n = 3$, 4%) of an intervention. Thirty-two studies (47%) included a usual care control group, whereas seven studies (10%) used waitlist-controls. The remaining studies ($n = 29$; 43%) included different combinations of active or attention control groups. Studies were conducted in North America ($n = 39$, 57%), Europe ($n = 13$, 19%), Australia ($n = 10$, 15%), and Asia ($n = 6$, 9%).

Intervention delivery features

Table 2 presents a summary of intervention descriptions and delivery characteristics are presented in Table 2. Most interventions were delivered completely by telehealth methods ($n = 44$, 65%), although 24 interventions (35%) had an in-person component. Most commonly used intervention delivery methods were telephone calls ($n = 61$ interventions, 90%), additional in-person component ($n = 24$, 35%), general internet portals ($n = 9$, 13%), and activity trackers ($n = 9$, 13%). Regarding the method of delivery, most of the studies used multiple delivery methods ($n = 39$, 57%) versus one type of delivery method ($n = 29$, 43%). The number of delivery methods ranged from 1 to 6, with a mean of 2.0 ($SD = 1.1$). Almost two-thirds of the studies ($n = 40$, 59%) used telephone calls as the only delivery method.

For most studies, the interventions were delivered through one-on-one provider to patient care ($n = 59$, 88%). Only three studies (4%) used interventions delivered to families or family dyads, three studies (4%) used groups of unrelated people, and three studies used a blend of group and individual interactions (4%). Duration of the interventions ranged from one to 52 weeks, with a mean of 16.5 weeks ($SD = 13.1$). Most interventions ($n = 53$, 78%) described a fixed number of interactions between the participant and provider, compared with a variable number of sessions ($n = 10$, 15%; $n = 5$ unreported, 7%) based on participant need.

Most interventions ($n = 39$, 57%) were delivered by practitioners in one discipline as opposed to those that involved practitioners from multiple disciplines ($n = 12$, 18%; not reported by 17, 25%). The most frequent discipline involved in intervention administration was nursing professionals ($n = 24$, 35%), followed by health-related research or graduate assistants ($n = 10$, 15%), physical therapy practitioners ($n = 9$, 13%), social workers ($n = 7$, 10%), or psychologists ($n = 7$, 10%) (see Table 2 for other discipline interventionists).

Functional disability outcome measures

The studies examined a variety of outcome measures related to disability and functional aspects of health-related quality of life (see Table 3). Less than half of the studies ($n = 32$, 47%) had a primary outcome measure assessing disability. We extracted data from 55 distinct outcome measures that assessed disability. In many instances, studies reported on specific subscales within the 55 outcome measures rather than composite scores. For example, Scura and colleagues [78] used two subscales of the Functional Assessment of Cancer Therapy—General (FACT-G) as independent outcome measures. If subscales were considered independent measures, the total number of unique outcome measures would be expanded to 84. Outcome tools were primarily self-report ($n = 40$, 73%) except for those that measured community mobility or community ambulation ($n = 15$, 27%). Community mobility was measured using performance-based measures of disability such as the Six Minute Walk Test. The most commonly reported outcome measures were the Functional Assessment of Cancer Therapy—General ($n = 13$, 19%), Medical Outcomes Study Short-Form (SF-36)—Physical Functioning Subscale ($n = 13$, 19%), Functional Assessment of Chronic Illness Therapy—Fatigue Scale (FACIT-F) ($n = 8$, 12%), and European Organisation for Research and Treatment Quality of Life (EORTC QLQC-30)—Physical Functioning Subscale ($n = 6$, 9%).

Table 1 Included studies ($n = 68$) participant characteristics

Authors, (year)	Sample size	Cancer type(s) included	Treatment status	Age (years), mean (*SD*)	% White
Abrahams (2017) [23]	132	Breast	Post-treatment	Intervention: 52.5 (8.2)	Not reported
Allard (2007) [24]	117	Breast	During primary treatment	Total sample: 53.6 (10.17)	Not reported
Anderson (2006) [25]	57	Breast, prostate, multiple myeloma, lung	During primary treatment	Total sample: 52	72%
Aranda (2006) [26]	105	Breast	Palliative	Intervention: 57 (median); Control: 55 (median)	Not reported
Ashing (2016) [27]	39	Breast	Post-treatment	Total sample: 55.5 (13.1)	0%
Ashing-Giwa (2008) [28]	23	Cervical	Post-treatment	Total sample: 49.75 (10.9)	Not reported
Badger (2013) [29]	80	Breast	During primary treatment	Total sample: 47.34(10.5)	0%
Bailey (2004) [30]	39	Prostate	Pre-treatment	Total sample: 75.4	86%
Barsevick (2004) [31]	396	Breast, lung, lymphoma, colorectal, genital (endometrial, ovarian, prostate, testicular)	During primary treatment	Total sample: 56.3 (12.5)	91%
Basen-Engquist (2020) [32]	37	Breast	During primary treatment	Intervention: 49.6 (13.3); Control: 49.2 (9.2)	59%
Bennett (2007) [33]	56	Breast. Other	Post-treatment	Intervention: 55.5 (8.9); Control: 60.1 (11.0)	98%
Bruera (2013) [34]	190	Gastrointestinal, lung, breast, genitourinary, melanoma, hematologic, other	Palliative	Total sample: 57.5 (median), range 24–84	72%
Burns (2017) [35]	82	Head and neck	During primary treatment	Intervention: 64 (*SD* 7.58); Control: 65 (*SD* 7.45)	Not reported
Chambers (2012) [36]	740	Prostate	Pre-treatment	Age at diagnosis: Intervention: 63.34 (7.59); Control: 63.43 (7.46)	Not reported
Chan (2020) [37]	202	Prostate	During primary treatment, post-primary treatment	Total sample: 70 (median)	92.6%
Cheville (2013) [38]	66	Lung, colorectal	During primary treatment	Intervention group: 63.8 (12.5); Control group: 65.5 (8.9)	100%
Cheville (2018) [39]	516	Stage IIIC or IV solid tumors, multiple myeloma, myelodysplastic syndrome, or Stage IIIC or IV lymphoma were enrolled	During primary treatment	Total sample: 65.6 (11.1)	95.3%
Cheville (2019) [40]	516	"Pathologically confirmed stage IIIC or IV solid or hematologic cancer"	During primary treatment	Total sample: 65.6 (11.1)	Not reported
Chow (2020) [41]	41	Leukemia, lymphoma, other	Post-treatment	Total sample: 45.1 (median)	78%
Clark (2013) [42]	131	Brain, gastrointestinal, head and neck, lung, other	During primary treatment	Total sample: 58.7 (10.6)	97%
Dennett (2018) [43]	46	Breast, prostate, non-Hodgkin's lymphoma, colorectal, gynecological, liver, pancreas, Hodgkin's lymphoma, kidney, lung, acute myeloid leukemia	During primary treatment	Total sample: 59 (12)	Not reported
Djuric (2011) [44]	40	Breast	Pre-treatment	Intervention non-completers 52.0 (6.9); Intervention completers 52.3 (9.5)	99%

Table 1 (continued)

Authors, (year)	Sample size	Cancer type(s) included	Treatment status	Age (years), mean (*SD*)	% White
Dong (2019) [45]	50	Breast	Post-treatment	Intervention: 48.00 (5.54); Control: 51.63 (7.49)	Not reported
Dong (2020) [46]	44	Breast	Post-treatment	Intervention: 50.4 (7.4); Control: 52 (8.5)	Not reported
Dos Santos (2020) [47]	167	Breast, digestive, hematologic	Post-treatment	Total sample: 51 (median)	Not reported
Duijts (2012) [48]	422	Breast	Post-treatment	Total sample: 48.2 (5.6)	Not reported
Ferguson (2016) [49]	47	Breast	Post-treatment	Total sample: 54.6 (12.12)	100%
Fjell (2020) [50]	149	Breast	During treatment	Intervention: 48 (10.6); control: 50 (11.6)	Not reported
Freeman (2015) [51]	118	Breast	Post-treatment	Live delivery: 55.44 (8.08); Telemedicine: 55.57 (9.88); Waitlist Ctrl: 55.28 (7.90)	87%
Galiano-Castillo (2017) [52]	81	Breast	Post-treatment	Total sample: 48.3 (8.8)	Not reported
Galiano-Castillo (2016) [53]	81	Breast	Post-treatment	Intervention: 47.4 (9.6); control: 49.2 (7.9)	Not reported
Gell (2020) [54]	66	Breast, cervical, endometrial, lung, leukemia, lymphoma, urinary, melanoma, rectal, oral, ovarian, prostate	Post-treatment	Total sample: 61.4 (9.0)	98.5%
Gordon (2015) [55]	410	Colorectal	During primary treatment	Total sample: 66.3 (10.1)	Not reported
Hawkes (2013) [56]	410	Colorectal	Post-treatment	Total sample: 66.35	Not reported
Hawkins (2017) [57]	300	Prostate	During primary treatment	Experimental: 60.71 (7.54) Control 1: 59.44 (6.40); Control 2: 60.53 (7.44);	Not reported
Hayes (2013) [58]	194	Breast	During primary treatment	Not reported	Not reported
Hegel (2011) [59]	29	Breast	During primary treatment	Total sample: 52.6 (9.4)	100%
Hung (2014) [60]	37	Lymphoma, myeloma	Post-treatment	Intervention: 57.5 (9.8); Usual care: 59.9 (9.2)	Not reported
Jensen (2012) [61]	95	Prostate	Post-treatment	Intervention: 64.1 (62.5–65.8); Control: 62.5 (60.9–64.2)	Not reported
Kelleher (2021) [62]	31	Colorectal	Post-treatment	Total sample: 59.6 (10.5)	96.8%
Kim (2020) [63]	326	Breast	During treatment	Total sample: 52	87.0%
Koller (2018) [64]	39	Gastrointestinal, breast, gynecological, lung, multiple myeloma, other	Palliative	Total sample: 56.6 (10.6)	Not reported
Lahart (2016) [65]	80	Breast cancer	Post-treatment	Total sample: 53.6 (9.4)	78%
Lee (2019) [66]	96	Prostate	Post-treatment	Intervention: 69.06 (7.21); Control: 69.82 (7.73)	Not reported
Ligibel (2012) [67]	121	Breast, colon, rectal	Post-treatment	Total sample: 54 (995)	91.7%
Meneses (2020) [68]	432	Breast	Post-treatment	Not reported	94.2%
Meneses (2018) [69]	40	Breast	Post-treatment	Total sample: 56.63 (10.26)	62.5%
Meneses (2009) [70]	53	Breast	Post-treatment	Total sample: 53.58 (11.55)	94.3%

Table 1 (continued)

Authors, (year)	Sample size	Cancer type(s) included	Treatment status	Age (years), mean (*SD*)	% White
Meneses (2007) [71]	256	Breast	Post-treatment	Total sample: 54.5 (11.58)	82%
Morey (2009) [72]	641	Breast, colorectal, prostate	Post-treatment	Intervention 73.0 (5.0); Control 73.1 (5.1)	89%
Pinto (2005) [73]	86	Breast	Post-treatment	Total sample: 53.42 (9.08)	96.4%
Pinto (2013) [74]	192	Breast	Post-treatment	Total sample: 60.0 (9.9)	93.8%
Pinto (2013) [75]	46	Colorectal	Post-treatment	Total sample: 57.3 (9.7)	98%
Raphaelis (2020) [76]	153	Gynecological, gastrointestinal, ears, nose, throat, lung, hematological, bone, breast, Other	During treatment and post-treatment	Intervention: 58.6; Control: 58.9	
Sajid (2016) [77]	19	Prostate	During primary treatment	Total sample: 70	73.7%
Scura (2004) [78]	17	Prostate	Pre-treatment	Total sample: 66 (8.3)	59%
Silvers (2014) [79]	21	Esophageal, stomach	Pre-treatment	Intervention: 72 (12); Control: 64 (14)	Not reported
Sui (2020) [80]	200	Lung	During treatment and post-treatment	Intervention: 61.37 (11.21); Control: 62.35 (9.98)	Not reported
Syrjala (2018) [81]	337	Acute leukemia, chronic myelogenous leukemia, non-Hodgkin's lymphoma, myelodysplasias, multiple myeloma, Hodgkin's lymphoma, other	Post-treatment	Total sample: 51 (12)	94%
Temur (2019) [82]	61	Breast	Post-treatment	Intervention group: 47.6 (8.96); Control group: 45.6 (9.03)	Not reported
Vallerand (2018) [83]	51	Leukemia, Hodgkin's lymphoma, non-Hodgkin's lymphoma	During primary treatment	Total sample: 52.6 (13.7)	Not reported
Waller (2021) [84]	22	Abdominal	Pre-treatment	Intervention: 55.5; Control: 61	Not reported
Wang (2019) [85]	60	Oral	During primary treatment	Total sample: 55.98 (11.73)	Not reported
Wenzel (2015) [86]	204	Cervical	Post-treatment	Total sample: 43	51.4%
Yanez (2015) [87]	74	Prostate	During primary treatment	Total sample: 68.84 (9.23)	56.8%
Yates (2005) [88]	109	Breast	During primary treatment	Total sample: 49.4 (9.4)	Not reported
Zhang (2015) [89]	244	Prostate	Post-treatment	Support group: 66.8 (7.2); Telephone group: (64.3 (7.3); Control: 64.9 (8.2)	62.7%
Zhou (2020) [90]	111	Breast	Pre-treatment and during primary treatment	Intervention: 49.84 (8.85)	Not reported

Table 2 Summary of intervention description and delivery features

Author (year)	Brief intervention description	Mode of delivery	Format	Duration and frequency of intervention	Interventionist (discipline)	Comparison condition(s)
Abrahams (2017) [23]	Cognitive-behavioral model of face-to-face and web-based modules reviewing precipitating and perpetuating factors of fatigue	General internet portal; Telephone calls; In-person	Individual	24 weeks Fixed Interactions: 3	Psychology	Wait list
Allard (2007) [24]	Psychoeducational telephone intervention designed to help women direct their focus of attention toward the functional pathway of coping	Telephone calls	Individual	2 weeks Fixed Interactions: 2	Nursing	Usual care
Anderson (2006) [25]	20-min audiotape included positive mood statements and positive imagery suggestions	Telephone calls	Individual	2 weeks Not reported Nurses called "periodically"	Nursing	Distraction audiotape; Relaxation audiotape; Wait list
Aranda (2006) [26]	Cognitive-behavioral techniques and education	Telephone calls	Family dyad or group	1 week Fixed Interactions: 2	Nursing	Usual care
Ashing (2016) [27]	Psychoeducation	Telephone calls	Individual	16 weeks Fixed Interactions: 8	Health-related Research Assistant	Usual care
Ashing-Giwa (2008) [28]	Problem-focused Cognitive Behavioral Therapy	Telephone calls	Individual	12 weeks Fixed Interactions: 6	Health-related Research Assistant	Usual care
Badger (2013) [29]	Enhancing emotional support both through the direct effects of the interaction with the interventionist and mobilizing the survivors' naturally occurring support	Telephone calls	Family dyad or group	8 weeks Fixed Interactions: 8	Social Work	Telephone health education
Bailey (2004) [30]	Watchful waiting intervention to manage uncertainty via cognitive reframing	Telephone calls	Individual	5 weeks Fixed Interactions: 5	Nursing	Usual care
Barsevick (2004) [31]	Energy conservation and activity management	Telephone calls	Individual	3 weeks Fixed Interactions: 3	Nursing	Attention control (information on nutrition)
Basen-Engquist (2020) [32]	To educate and enhance self-efficacy in the size acceptance approach	Telephone calls	Individual	25 weeks Fixed Interactions: 20	Masters-level Health Educators	Usual care

Table 2 (continued)

Author (year)	Brief intervention description	Mode of delivery	Format	Duration and frequency of intervention	Interventionist (discipline)	Comparison condition(s)
Bennett (2007) [33]	Motivational interviewing to facilitate 30 daily minutes of moderate to vigorous physical activity	Telephone calls	Hybrid	16 weeks Fixed Interactions: 4	Social Work	Two phone calls (brief, social conversations)
Bruera (2013) [34]	Methylphenidate + nursing phone intervention	Telephone calls	Individual	2 weeks Variable	Nursing	Methylphenidate + control phone intervention; Placebo + nursing phone intervention; Placebo + control phone intervention
Burns (2017) [35]	Speech pathology telepractice	Video Conferencing; Telephone calls; In-Person; Other	Individual	Not reported	Speech Language Pathology	Usual care
Chambers (2012) [36]	Psycho-education, stress management, coaching, decision support and cognitive reframing	Telephone calls	Individual	20 weeks Fixed Interactions: 5	Nursing	Usual care
Chan (2020) [37]	Web-based behavioral support with two optional calls with dietician and/or exercise physiologist	General Internet Portal; Telephone calls; Activity tracker; Text	Individual	12 weeks Variable 4 interactions (2 optional calls)	Dietetics; Exercise Physiology	Level 1: General information and guidelines via website; Level 2: Level 1 plus personalized diet and exercise prescriptions and videos and survey about progress; Level 3: Level 2 plus Fitbit Alta with physical activity reports and supportive text messages
Cheville (2013) [38]	Exercise plus pedometer-based walking program	Telephone calls; In-Person	Individual	8 weeks Fixed Interactions: 5	Physical Therapy	Usual care
Cheville (2018) [39]	Three Component Model (TCM)-Rehabilitation Services plus conventional TCM pain management	Telephone calls; Activity trackers	Individual	26 weeks Fixed Interactions: 8	Physical Therapy; Nursing; MD	Three component model rehabilitation; Exercise plus pedometer
Cheville (2019) [40]	Telerehabilitation with pharmacological pain management arm	General internet portal; Telephone calls; Activity tracker; In-person	Individual	24 weeks Variable	Physical Therapy; Nursing; MD	Usual care

Table 2 (continued)

Author (year)	Brief intervention description	Mode of delivery	Format	Duration and frequency of intervention	Interventionist (discipline)	Comparison condition(s)
Chow (2020) [41]	Mobile health supported intervention to improve diet and physical activity	Telephone calls; Text-messaging; General internet portal; Activity Tracker; Facebook group; Mobile application	Individual	16 weeks Fixed Interactions: # not reported	Health-related Research Assistant	Access to the Fitbit tracker and Healthwatch360 app
Clark (2013) [42]	Multi-disciplinary counseling intervention to maintain quality of life	Telephone calls	Hybrid	27 weeks Fixed Interactions: 17	Physical Therapy; Psychology; Social Work; Nursing	Usual care
Dennett (2018) [43]	Motivational interviewing plus aerobic and resistance exercise, individual and group education	Telephone calls	Individual	7 weeks Fixed Interactions: 7	Physical Therapy	Oncology rehabilitation of exercise and education
Djuric (2011) [44]	Motivational interviewing; Education and counseling	Telephone calls	Individual	52 weeks Variable	Dietetics	Education, pedometer, log, newsletters
Dong (2019) [45]	Remotely-guided muscle training, endurance training, and education	Video Conferencing; Instant Messaging or Texting; Mobile Application; Activity Tracker	Individual	12 weeks Fixed Interactions: 84	Physical Therapy	Usual care (traditional rehabilitation)
Dong (2020) [46]	Remotely-guided muscle training, endurance training, and education	Video Conferencing; Instant Messaging or Texting; Mobile Application; Activity Tracker	Individual	12 weeks Fixed Interactions: 84	Physical Therapy	Usual care (traditional rehabilitation)
Dos Santos (2020) [47]	Computer-Assisted Cognitive Rehabilitation	Other (computer program)	Individual	12 weeks Fixed Interactions: 9	Neuropsychology	Telephone calls; Cognitive exercises at home via workbook
Duijts (2012) [48]	Cognitive Behavioral Therapy and relaxation exercises	Telephone calls; In-person	Group	6 weeks Fixed Interactions: 6	Physical Therapy; Psychology; Social Work	Physical exercise
Ferguson (2016) [49]	Cognitive Behavioral Therapy	Video conferencing	Individual	8 weeks Fixed Interactions: 8	Psychology	Behavioral placebo (supportive therapy)
Fjell (2020) [50]	Interaktor: Real-time cancer sequelae monitoring	Text messaging; Mobile Application; Telephone calls; In-person	Individual	18 weeks Variable	Nursing; Health-related Research Assistant	Usual care

Table 2 (continued)

Author (year)	Brief intervention description	Mode of delivery	Format	Duration and frequency of intervention	Interventionist (discipline)	Comparison condition(s)
Freeman (2015) [51]	Education; mind–body connection; imagery techniques	Video Conferencing; Telephone Calls	Group	17 weeks Fixed Interactions: 17	Social Work; Medical Physician	In-person delivery
Galiano-Castillo (2017) [52]	Tailored exercise program	Video Conferencing; General Internet Portal; Instant Messaging or Texting; Telephone calls	Individual	8 weeks Fixed Interactions: 24	Not specified	Education regarding health benefits of physical activity; Written general exercise guidelines
Galiano-Castillo (2016) [53]	Online system that facilities remote rehabilitation and consists of public and private interfaces with updated information about breast cancer	Video Conferencing; General Internet Portal; Instant Messaging or Texting; Telephone calls	Individual	8 weeks Fixed Interactions: 24	Not specified	Written recommendations
Gell (2020) [54]	Health coaching	Instant Messaging or Texting; Telephone calls; Activity Tracker	Individual	8 weeks Fixed Interactions: 4	Not specified	Fitbit only
Gordon (2015) [55]	Health coaching	Telephone calls	Individual	24 weeks Fixed Interactions: 11	Not specified	Usual care
Hawkes (2013) [56]	Health coaching	Telephone calls	Individual	24 weeks Fixed Interactions: 12	Psychology; Nursing; Health-related Research Assistant	Usual care
Hawkins (2017) [57]	Comprehensive Health Enhancement Support System + Mentor	Telephone calls	Individual	24 weeks Fixed Interactions: 10	Human Cancer Information Mentor	Mentor only; CHESS only
Hayes (2013) [58]	Exercise	Telephone calls	Individual	32 weeks Fixed Interactions: 16	Exercise Physiologist	Telephone delivered exercise intervention; Usual care
Hegel (2011) [59]	Cognitive Behavioral Therapy	Telephone calls	Individual	6 weeks Fixed Interactions: 6	Occupational Therapy	Usual care
Hung (2014) [60]	Nutrition and exercise counseling	Telephone calls	Individual	12 weeks Variable	Dietetics; Exercise Physiology	Usual care
Jensen (2012) [61]	Telephone consultation	Telephone calls	Individual	1 week Fixed Interactions: 1	Nursing	Usual care
Kelleher (2021) [62]	Coping skills training	Telephone calls	Individual	5 weeks Fixed Interactions: 5	Health-related Research Assistant	Usual care

Table 2 (continued)

Author (year)	Brief intervention description	Mode of delivery	Format	Duration and frequency of intervention	Interventionist (discipline)	Comparison condition(s)
Kim (2020) [63]	Comprehensive Health Enhancement Support System + Mentor	In-Person; General Internet Portal; Telephone calls	Individual	24 weeks Fixed Interactions: 10	Cancer Information Specialist Mentor	Internet access with list of websites; Comprehensive Health Enhancement Support System—Information and Support (CHESS-IS)
Koller (2018) [64]	Education, skill building, and coaching to support self-management	Telephone calls; In-person	Individual	6 weeks Not reported	Nursing	Usual care
Lahart (2016) [65]	Physical activity counseling	Telephone calls; In-Person; Other	Individual	24 weeks Not reported	Not specified	Usual care
Lee (2019) [66]	Exercise	Telephone calls; Mobile Application; Other	Individual	12 weeks Not reported	Medical Physician	Pedometer
Ligibel (2012) [67]	Exercise	Telephone calls	Individual	16 weeks Variable 10–11 interactions	Social Work	Usual care
Meneses (2020) [68]	Education and support	Telephone calls; In person; Mail	Individual	52 weeks Fixed Interactions: 11	Nursing	Delayed support
Meneses (2018) [69]	Education	Telephone calls; Other	Individual	3 weeks Fixed Interactions: 9	Not specified	Wait list
Meneses (2009) [70]	Psychoeducation and support	Telephone calls; In-person	Individual	28 weeks Fixed Interactions: 8	Nursing	Wait list
Meneses (2007) [71]	Psychoeducation and support	Telephone calls; In-person	Individual	24 weeks Fixed Interactions: 9	Nursing	Wait list
Morey (2009) [72]	Counseling and education	Telephone calls	Individual	52 weeks Fixed Interactions: 15	Social Work	Wait list
Pinto (2005) [73]	Physical activity counseling	Telephone calls; Activity Tracker; In-person	Individual	12 weeks Fixed Interactions: 15	Health-related Research Assistant	Contact control
Pinto (2013) [74]	Advice and counseling	Telephone calls; In-Person; Other	Individual	12 weeks Fixed Interactions: 8	Not specified	Advice plus contact control
Pinto (2013) [75]	Physical activity	Telephone calls; In-Person;	Individual	12 weeks Fixed Interactions: 12	Health-related Research Assistant	Symptom surveys

Table 2 (continued)

Author (year)	Brief intervention description	Mode of delivery	Format	Duration and frequency of intervention	Interventionist (discipline)	Comparison condition(s)
Raphaelis (2020) [76]	Self-management support	Telephone calls; In-Person	Family Dyad or Group	Not specified Variable (based on pain intensity; maximum of 4 interactions)	Nursing	Usual care
Sajid (2016) [77]	Home-based walking and exercise	Telephone calls; Activity Tracker; In-person	Individual	6 weeks Fixed Interactions: 6	Exercise Physiology	Wii-fit; Usual care
Scura (2004) [78]	Support and education	Telephone calls; Other	Individual	52 weeks Fixed Interactions: 25	Nursing; Health-related Research Assistant	Education
Silvers (2014) [79]	Nutrition education and behavior change techniques	Telephone calls; In-person	Individual	26 weeks Fixed Interactions: 19	Not specified	Standard care
Sui (2020) [80]	WeChat app-based education and rehabilitation	Mobile App; In-person	Individual	52 weeks Fixed Interactions: 130	Nursing	One education session with telephone follow-up as needed
Syrjala (2018) [81]	Education, resources and Cognitive Behavioral Therapy	General Internet Portal; Telephone calls	Individual	24 weeks Variable	Psychology	Education and resources; Wait list
Temur (2019) [82]	Self-management for lymphedema using exercises and lymphatic drainage	Telephone calls; In-person	Individual	24 weeks Fixed Interactions: 6	Health-related Research Assistant	Usual care
Vallerand (2018) [83]	Counseling	Telephone calls	Individual	12 weeks Fixed Interactions: 12	Not specified	Written guidelines and goal
Waller (2021) [84]	Trimodal prehabilitation to promote physical activity, nutrition, and psychological well-being	Mobile Application; Activity Tracker; Telephone calls	Individual	Two weeks Variable	Physical Therapy	Usual care
Wang (2019) [85]	Support and monitoring	Telephone calls; In-person	Individual	12 weeks Fixed Interactions: 6	Nursing	Education pamphlet
Wenzel (2015) [86]	Psychosocial counseling	Telephone calls	Individual	9 weeks Fixed Interactions: 6 interactions	Not specified	Usual care
Yanez (2015) [87]	Cognitive behavioral stress management treatment	Video Conferencing; General Internet Portal	Group	10 weeks Fixed Interactions: 10	Occupational Therapy	Attention control of health promotion
Yates (2005) [88]	Psychoeducation	Telephone calls; In-person	Individual	3 weeks Fixed Interactions: 3	Nursing	General cancer education

Table 2 (continued)

Author (year)	Brief intervention description	Mode of delivery	Format	Duration and frequency of intervention	Interventionist (discipline)	Comparison condition(s)
Zhang (2015) [89]	Biofeedback exercise + support group	Telephone calls; In-person	Hybrid	12 weeks Fixed Interactions: 7	Psychology; Nursing	Exercise + telephone support; Usual care
Zhou (2020) [90]	WeChat app-based education and rehabilitation	Mobile application; In-person	Individual	26 weeks Fixed Interactions: 182	Medical Physician; Nursing; Health-related Research Assistant	Usual care

Estimated effect sizes

On average, the studies reported on 3.1 functional outcomes (range: 1–11 outcomes) for a total of 253 outcomes across 68 studies. Data to calculate between-group effect sizes was available for 154 (54%) of available outcomes (see Table 3). Effect sizes ranged from − 3.58 (clinically meaningful outcomes favoring control intervention) to 15.66 (highly clinically meaningful outcomes favoring the experimental intervention). Given the multitude of outcome measures, we further analyzed the four most used outcome measures to examine influence of telehealth-based cancer rehabilitation interventions on disability (see Fig. 2 for associated forest plots).

FACT-G

Of the thirteen articles contained the FACT-G, only seven articles contributed to the analysis. Two articles [25, 47] were comparative effectiveness studies as represented by two or more contrasts in Fig. 2. Heterogeneity across studies was not detected ($I^2 = 34\%$; $p = 0.14$); however, the interventions varied in content and delivery. The ten interventions represented had a small clinically meaningful effect on overall health-related quality of life (*SMD*: 0.2, CI: 0.0–0.3).

SF-36—physical functioning

Thirteen articles contained the SF-36 Physical Functioning subscale. Eight articles, representing ten distinct interventions, contributed to the pooled outcome. Heterogeneity across studies was detected ($I^2 = 98\%$; $p < 0.001$). Non-significant clinical reductions in perceived physical well-being favored the intervention; however, these were not significant (*SMD*: 0.3, CI: − 0.4 to 1.0).

FACIT-F

Of the eight articles used the FACIT-F, only three articles contributed to the pooled outcome. The three articles represented four distinct interventions. Heterogeneity across studies was detected ($I^2 = 81\%$; $p < 0.001$). The pooled outcome revealed a significant decrease in interference of fatigue on health-related quality of life (*SMD*: 0.8, CI: 0.3–1.4).

EORTC QLQC-30—physical functioning subscale

Of the six articles contained the EORTC QLQC-30—Physical Functioning Subscale, only four articles contributed to the pooled outcome. Heterogeneity across studies was detected ($I^2 = 55\%$; $p < 0.09$). The pooled outcome revealed a significant improvement perceived physical well-being (*SMD*: 0.5, CI: 0.1–0.9) among the available data.

Table 3 Summary of functional outcome measures and effect size ranges

Outcome tool	Number of articles including outcome tool	Number of articles with available effect sizes (*d*)	Range of effect sizes
Functional Assessment of Cancer Therapy—General (FACT-G)	13 [25, 27, 28, 38, 42, 44, 47, 62, 86–88]	7 [25, 27, 38, 42, 47, 62, 88]	−0.67 to 0.8
FACT-G – Physical Well-Being Subscale	2 [47, 78]	1 [47]	−0.22 to −0.16
FACT-G – Social Well-Being Subscale	1 [47]	1 [47]	−0.10 to 0.22
FACT-G – Emotional Well-Being Subscale	1 [47]	1 [47]	0.13–0.29
FACT-G – Functional Well-Being Subscale	3 [47, 49, 78]	2 [47, 49]	0.18–0.3
Medical Outcomes Study Short-Form (SF-36) – Total Score	6 [45, 55, 56, 59, 68, 83]	3 [45, 55, 83]	0.63–15.66
SF- 36—Physical Functioning Subscale	13 [32, 33, 36, 46, 48, 68, 69, 71, 75, 81]	8 [32, 33, 36, 46, 48, 71, 81]	−0.67 to 4.62
SF- 36 – Role Limitations Physical Subscale	3 [32, 46, 71]	3 [32, 46, 71]	0.08–4.34
SF- 36 – Role Limitations Emotional Subscale	2 [32, 46]	2 [32, 46]	−0.03 to 0.43
SF- 36 – Mental Well-Being Subscale	3 [32, 36, 46]	3 [32, 36, 46]	−2.04 to 0.89
SF- 36 – Vitality Subscale	3 [32, 45, 46]	3 [32, 45, 46]	0.63–4.39
SF- 36 – Physical Component Summary	1 [51]	1 [51]	0.16–0.54
SF- 36 – General Health Subscale	2 [32, 46]	2 [32, 46]	0.79–1.4
SF- 36 – Bodily Pain Subscale	2 [32, 46]	2 [32, 46]	−0.11 to 1.36
SF- 36 – Social Functioning Subscale	2 [32, 46]	2 [32, 46]	0.27–0.7
SF- 36 – Reported Health Transition Subscale	1 [46]	1 [46]	0.75
Short Form – 6D	1 [55]	1 [55]	−0.01
Functional Assessment of Chronic Illness Therapy – Fatigue Scale	8 [34, 38, 39, 51, 56, 58, 67, 75]	3 [38, 51, 67]	0.25–1.87
European Organisation for Research and Treatment Quality of Life (EORTC QLQC-30) – Total Score	4 [23, 26, 76, 79]	3 [23, 26, 79]	−0.05 to 2.54
EORTC QLQC-30 – Physical Functioning Subscale	6 [43, 50, 53, 60, 67, 82]	4 [43, 53, 60, 67]	0.06–1.02
EORTC QLQC-30 – Global Quality of Life Subscale	5 [43, 53, 60, 67, 80]	5 [43, 53, 60, 67, 80]	−3.58 to 3.47
EORTC-QLQ-C30—Emotional Function Subscale	5 [43, 50, 53, 60, 82]	3 [43, 53, 60]	0.0–0.77
EORTC-QLQ-C30—Cognitive Function Subscale	5 [43, 50, 53, 60, 82]	3 [43, 53, 60]	−0.31 to 0.86
EORTC-QLQ-C30—Social Function Subscale	5 [43, 50, 53, 60, 82]	3 [43, 53, 60]	0.26–0.76
EORTC-QLQ-C30 – Role Function Subscale	4 [26, 50, 53, 82]	2 [26, 53]	−0.07 to 0.9
Functional Assessment of Cancer Therapy—Breast (FACT-B)	5 [44, 51, 65, 90, 91]	4 [44, 51, 65, 90]	−0.05 to 0.92
FACT-B – Physical Well-Being Subscale	3 [59, 65, 90]	2 [65, 90]	−0.22 to −0.03
FACT-B – Social Well-Being Subscale	1 [90]	1 [90]	0.97
FACT-B – Emotional Well-Being Subscale	1 [90]	1 [90]	0.37
FACT-B – Functional Well-Being Subscale	3 [59, 65, 90]	2 [65, 90]	−0.2 to 1.25
FACT-B4	1 [58]	0	–
Six Minute Walk Test	5 [33, 43, 52, 67, 84]	4 [33, 43, 52, 67]	0.32–0.6
Brief Pain Inventory – Pain Interference Subscale	3 [53, 64, 76]	1 [64]	−0.76 to 0.42
Activity Measure for Post-Acute Care Mobility Short Form	3 [38–40]	1 [38]	1.05
EuroQol- 5 Dimension	3 [39, 40, 79]	1 [79]	1.7
Moderate Intensity Physical Activity	3 [43, 56, 60]	3 [43, 56, 60]	−0.19 to 0.22

Table 3 (continued)

Outcome tool	Number of articles including outcome tool	Number of articles with available effect sizes (*d*)	Range of effect sizes
Daily Steps	3 [41, 43, 77]	1 [43]	0.38
Seven -Day Physical Activity Recall (min/week)	2 [67, 74]	1 [67]	0.31
Stand-up and sit-down chair test	2 [45, 46]	2 [45, 46]	0.91–1.25
Arm Lifting Test	2 [45, 46]	2 [45, 46]	−2.43 to 0.65
Trial Outcome Index	2 [65, 86]	1 [65]	−0.04
The World Health Organization Quality of Life (WHOQOL)	2 [57, 91]	0	–
QOL-BC—Social Well-Being Subscale	2 [70, 71]	1 [70]	−0.27
Functional Assessment of Cancer Therapy-Cognition (FACT-Cog) – Quality of Life Subscale	2 [47, 49]	2 [47, 49]	0.12–0.43
PEG Scale Assessing Pain Intensity and Interference	2 [39, 40]	0	–
Moderate to Vigorous Physical Activity	2 [41, 54]	1 [54]	0.39
Disabilities of the Arm, Shoulder and Hand Questionnaire	2 [58, 82]	0	–
European Organisation for Research and Treatment Quality of Life – Breast Cancer (EORTC QLQ-BR23) – Sexual Function Subscale	1 [82]	0	–
EORTC QLQ-BR23 – Sexual Enjoyment Subscale	1 [82]	0	–
Quality of Life –Breast Cancer Survivors–Physical Health Subscale	1 [64]	1 [64]	0.6
Piper Fatigue Scale-revised	1 [53]	0	–
Multidisciplinary Fatigue Inventory	1 [29]	1 [29]	0.29
Functional Assessment of Cancer Therapy – Colorectal	1 [74]	0	–
Functional Assessment of Cancer Therapy – Cervix	1 [86]	0	–
Functional Assessment of Cancer Therapy-Endocrine Subscale	1 [48]	1 [48]	0.22–1.48
Functional Assessment of Cancer Therapy – Anemia	1 [47]	1 [47]	0.08–0.22
Functional Assessment of Cancer Therapy – Prostate	1 [57]	0	–
Expanded Prostate Cancer Index Composite	1 [57]	0	–
Cantril's Ladder of Life	1 [30]	1 [30]	0.45
Functional Performance Inventory	1 [31]	0	–
Community Healthy Activities Model Program for Seniors	1 [33]	1 [33]	0.1
Sickness Impact Profile – 8	1 [23]	0	–
Symptoms Impact Profile	1 [24]	1 [24]	−0.31
AMPAC Activity Short Form	1 [38]	1 [38]	0.13
UCLA Prostate Cancer Index—Sexual Bother Subscale	1 [36]	1 [36]	0.03
UCLA Prostate Cancer Index—Urinary Incontinence Subscale	1 [89]	0	–-
Total Physical Activity	1 [65]	1 [65]	−0.07
Gait Speed	1 [66]	1 [66]	−0.27
2-Min Walk Test	1 [66]	1 [66]	0.19
30-Second Chair Stand Test	1 [66]	1 [66]	0.47

Table 3 (continued)

Outcome tool	Number of articles including outcome tool	Number of articles with available effect sizes (*d*)	Range of effect sizes
International Physical Activity Questionnaire	1 [65]	1 [65]	−0.07
Late-Life Function & Disability Instrument – Basic Lower Extremity Function Subscale	1 [72]	1 [72]	3.72
Late-Life Function & Disability Instrument – Advanced Lower Extremity Function Subscale	1 [72]	1 [72]	3.63
Swallowing Function: Maximum interincisal opening and Mandible Function Impairment	1 [85]	1 [85]	−1.40 to 1.26
Godin Leisure Time Exercise Questionnaire	1 [83]	1 [83]	2.91–4.22
Champs Survey (Physical Activity and Lifestyle Behavior Subscales)	1 [37]	0	–
PROMIS® Global Health (Physical and Mental Health Subscales)	1 [41]	0	–
PROMIS® Depression Scale	1 [87]	0	–
Short Physical Performance Battery	1 [77]	0	–
International Index of Erectile Function Scale	1 [78]	0	–
3-Min Step Test	1 [58]	0	–
One Mile Walk Test	1 [73]	0	–
Tread walk Test	1 [74]	0	–
Sit to Stand Test	1 [43]	0	–

Discussion

This systematic review assesses the current state of the science and effectiveness of telehealth-based cancer rehabilitation interventions influencing disability. Included studies were randomized controlled trials with at least one synchronous intervention delivery component and incorporated a measure of disability as a primary or exploratory outcome. Given the available data, telehealth-based cancer rehabilitation interventions appear to have a small positive effect on quality of life as measured by the FACT-G and FACIT-F measurement system, which includes an assessment of a person's perceived ability to function in daily life. The effect on physical functioning is less clear, with no effect seen when measured by the SF-36 and a small effect seen when measured by the EORTC QLQC-30. It is possible that the effects are underestimated because disability and health-related quality of life measures were not the primary outcome for the majority of the studies. In other words, a study intervention with a primary purpose to reduce a specific symptom (e.g., pain, cognitive deficits, balance) may not generalize to reductions in disability or health-related quality of life.

In sum, telehealth-based cancer rehabilitation does have an impact that merits further evaluation and study; however, the descriptive results indicate that future research will need to include more diverse patient populations, create more consensus around appropriate measure selection, and focus on implementation science methods to address challenges to translating evidence into practice.

Patient populations and study characteristics

Studies included in this systematic review were not evenly distributed across cancer type, timing of treatment/intervention, and location. Included studies were heavily weighted toward individuals with breast cancer ($n = 30$, 60%) and post-primary treatment interventions ($n = 34$, 50%). This is somewhat unsurprising as breast cancer is the most frequently diagnosed new cancer in women in the USA [92] and one of the most common diagnoses in more than 25 countries globally [93]. In addition, the field of cancer survivorship was initially conceptualized as beginning post-treatment completion [94]. Thus, this skew toward post-treatment intervention is consistent with the larger body of literature in cancer and rehabilitation and prevalence estimates. However, it presents three challenges. First, findings may have limited utility in determining implications for other cancer populations. Second, the implications for delivery outside the post-treatment phase also remain somewhat unclear and exposes the relatively smaller bodies of research examining effectiveness in the pre-treatment phase, during treatment, and end-of-life care. Lastly, study locations were primarily located in the USA and Northern Europe, not only limiting generalizability to many indigenous peoples and non-Western countries but also potentially reflecting lack of access to telehealth-based cancer rehabilitation services in low-income countries.

Race and ethnicity of study participants presented another area of imbalance in the included studies. Of the studies that reported ethnicity ($n = 38$, 56%), participants were almost

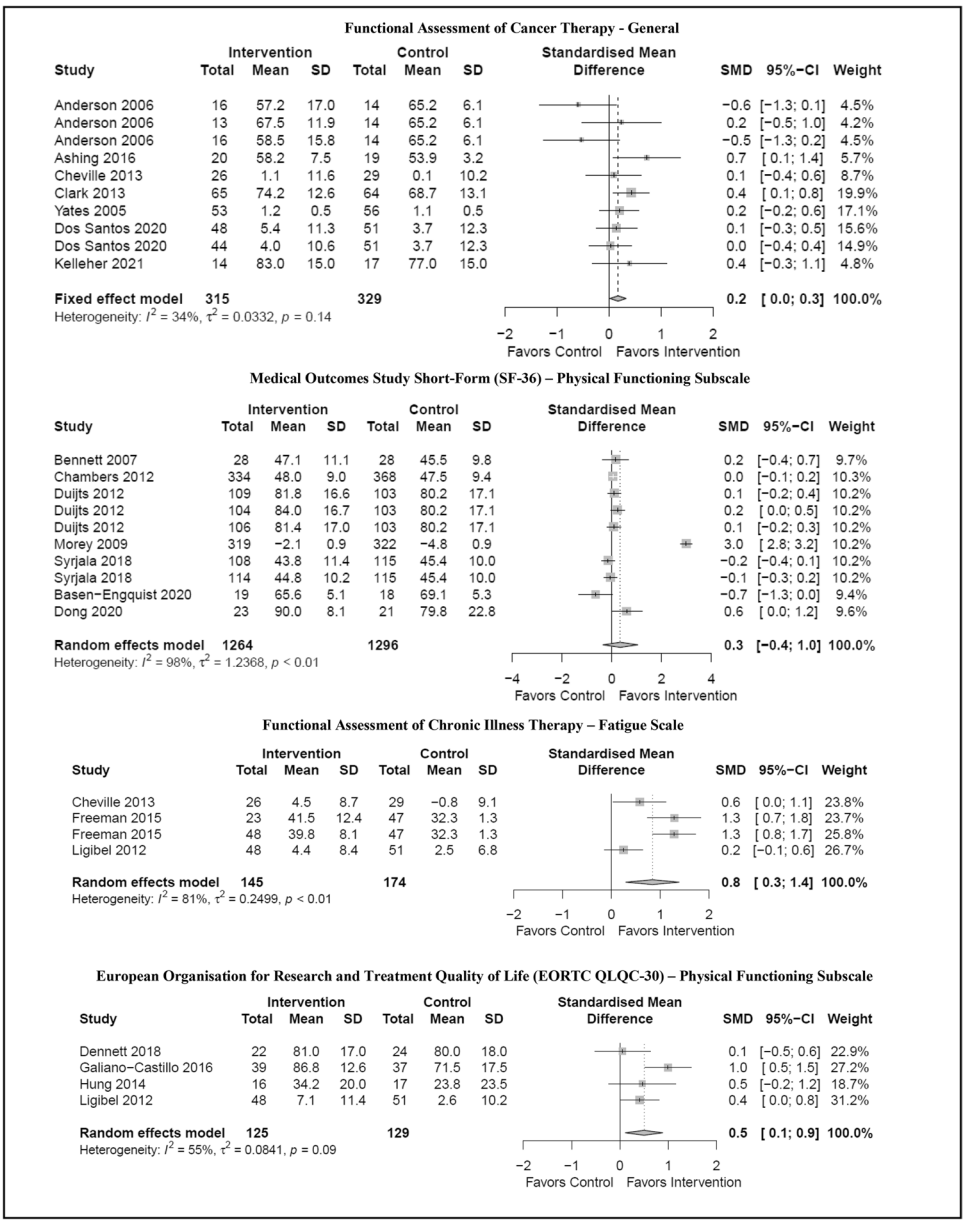

Fig. 2 Forest plots of most commonly reported functional outcome measures with available data increase font of each section of figure

exclusively White and non-Hispanic. The high number of White participants, as well as the large number of studies that did not report ethnicity ($n = 30$, 44%), may limit the ability to generalize findings to other race and ethnicity groups. Similar to findings in this review, this has been a persistent challenge in the larger world of clinical trials [95], including in rehabilitation medicine [96]. This lack of inclusion for historically or socially marginalized groups may undermine personalized medicine efforts and contribute to the persistence of health inequities [97]. The results described in our analysis indicate that there are challenges to translation in clinical care settings beyond individuals with breast cancer and individuals outside of economically developed nations and socially marginalized populations.

There are consequences associated with ongoing lack of inclusion of historically or socially marginalized groups in cancer rehabilitation research and clinical practice. Lack of representative study samples may prevent researchers and clinicians from delivering high-quality patient-centric care [96]. Furthermore, lack of examination of social determinants of health on access, delivery, or effectiveness of telehealth-based cancer rehabilitation may perpetuate healthcare disparities and sub-optimal outcomes among vulnerable populations. Without evidence that acknowledges the influence of telehealth-based cancer rehabilitation services among marginalized groups, we are at risk of constraining the growth or applicability of the cancer rehabilitation field among the broader cancer community and inefficiently

utilizing costly healthcare and research resources [96]. Thus, future research and clinical practice using telehealth-based cancer rehabilitation interventions must leverage research designs and clinical practice delivery that support inclusion of historically or socially marginalized groups.

Outcomes and measurement

When evaluating the effectiveness of interventions, one significant challenge was attributed to the number of measures utilized across the included studies. In this review, we found a wide range of patient-reported and performance-based measures of disability, specifically, 55 different measures (or 84 if you consider the sub-scales of larger patient-reported outcome measures). Similar to previous studies [98, 99], this has led to difficulty in determining outcome magnitude and direction across this body of research [100]. Furthermore, the measures most frequently used in this study are typically free for research, but may not be financially feasible in clinical practice [101]. This places additional financial burden on clinics that who have to pay per patient to use the measure as well as cover costly and time-consuming data entry solutions.

For research and systematic reviews to inform clinical practice, guidelines, and policy, the outcomes chosen need to be prioritized in terms of meaningfulness to the patients served. Second, the outcomes chosen in clinical research should be standardized to decrease potential bias, poor selection of measures with lacking psychometrics, or gathering data that may not be relevant across studies which prevent further synthesis and knowledge gained. It is challenging to integrate this research directly into clinical practice as well as for the clinical practice to be prepared to gather relevant data. There is some recent work that seeks to harmonize outcome measures to place multiple measures onto one metric and, therefore, allow meta-analysis or comparative effectiveness research to occur [102]. Until harmonization efforts are underway, standardized, and easy to use and understand in a busy clinical practice, in clinic- or telehealth-based cancer rehabilitation, we strongly encourage a consensus and collaboration to determine measures that have clinical utility and research utility.

Intervention development and intervention considerations

Technology and patient preferences

The significant role of "old" or "low-tech" technology of the telephone ($n=40$, 59%) stands out in contrast to rapid upscaling of video technology during the COVID-19 pandemic. Although our inclusion of articles spanned through April 2021, our dataset contained only 11 articles published in 2020 or 2021 and most of them were accepted for publication prior to March 2020. It is likely that our inclusion criterion regarding the use of an RCT design limited our ability to capture and describe studies that incorporated video technology and newer telehealth platforms that were introduced in the COVID-19 pandemic era.

During the COVID-19 pandemic, less restrictive use of telehealth has been permitted within the USA [103], including reimbursement for services provided by telephone. Globally, utilization of telehealth-based services tended to use different types of telehealth services based on the health condition or severity of complaint [104]. Nevertheless, if telehealth-based cancer rehabilitation via telephone delivery is deemed a non-reimbursed service post-pandemic, it limits use of an easily accessible mode of delivery. There is little research comparing patient preferences for phone versus other telehealth delivery methods; however, three recent studies [105–107] in oncology supportive services and medical consultation have examined patient preferences and satisfaction. These studies found that a plurality of patients preferred telephone delivered care over face-to-face and/or video delivered care. Interestingly, one study in Canada found comprehensive functional assessments could also be delivered primarily via telephone and supplemented with one or two in-person visits [107]. Qualitative methods examining patient preferences and satisfaction with telehealth-based cancer rehabilitation services can help shape modes of delivery in future and existing interventions across global healthcare systems.

Professional disciplines

In our results, over one-third ($n=24$, 35%) of study interventions were delivered by nursing professionals. Our classification of nursing professionals included nursing assistants, nurses, and nurse practitioners. The billing implications of this finding are unclear given the wide range of legal independent practice ability and billing requirements within this category. Moreover, varying scope of practice issues (i.e., implementing an intervention versus setting and advancing the plan of care) between rehabilitation clinicians also render this finding challenging to interpret and implement. Given the breadth of interventionists and missing data, we were unable to identify if differences in discipline delivery influenced improvement in disability. Future research can elucidate differences in outcomes based on discipline.

Intervention characteristics

Interventions varied in duration and time and format of delivery. The mean intervention duration was 16.5 weeks. In conjunction with our findings, most studies were delivered post-treatment. In addition, interventions varied in intensity

and format (i.e., one-on-one services to group therapy). Therefore, it may be possible that intervention intensity also impacts duration. Moreover, real-world application of these findings may not be feasible in regional and/or global clinical settings. For example, the duration may not accurately reflect the shorter timetables necessary for telehealth-based cancer rehabilitation interventions prior to initiating primary treatment or in the context of advanced disease or end of life.

Limitations

To our knowledge, this is the first systematic review to broadly address the effectiveness of telehealth-based cancer rehabilitation in cancer survivors. Given this, we chose a wide lens through which to select eligible studies to provide the broadest perspective on randomized controlled trials in this area of practice. That said, there are limitations. First, inclusion of only randomized controlled trials may have led us focus on efficacy trials in academic settings and miss pragmatic trials in clinical settings, including those stimulated by the COVID-19 pandemic. Although there were eleven articles published between 2020 and 2021 [32, 37, 41, 46, 50, 62, 71, 76, 80, 84, 90], no articles took place during or referenced the COVID-19 pandemic. Future research should consider differences among pre-, during-, and post-pandemic telehealth-based cancer rehabilitation intervention research in terms of populations reached, functional measures used and associated outcomes, as well as technology platforms utilized. This information could be used to influence health system access and broader policy related to telehealth reimbursement and utilization.

Second, creating an operational definition of cancer rehabilitation was a challenge that introduced heterogeneity into the sample. As such, our review is broad and expansive and may include interventions that the authors may not have identified as rehabilitation. Co-authors also represented a broad range of professional disciplines and expertise to capture all interventions that may be considered as cancer rehabilitation.

For this study, we chose not to analyze active ingredients or components of the included interventions as our primary focus was to characterize delivery and evaluate the effect on disability. Future work will identify and examine which active ingredients or intervention content influence function and disability via telehealth-based services the most. Following this, future research may also consider stakeholder input on preferred or prioritized types of intervention to be delivered via telehealth to ensure value of future intervention.

We chose to include studies with some concerns and high risk of bias in order to comprehensively characterize the state of the science in this area. Thus, inclusion of this evidence helps to broaden our understanding of potential implications for future intervention development, implementation, and policy applications. However, given the large amount of missing data (i.e., raw means and standard deviations) and moderate to high risk of bias associated with many included studies, the certainty, or the test of accuracy, of our findings may have been impacted. The variation in interventions and outcome measures included in this systematic review preclude meta-analysis. No inquiries were made to the authors of the original articles for clarification or missing data which could affect the validity of the effectiveness analysis. While our analyses indicated small positive effects on disability, heterogeneity across population and intervention characteristics prevent us from drawing firm conclusions.

Conclusion

To summarize, in the rapidly changing context of science, practice, and policy, telehealth-based cancer rehabilitation demonstrates a positive impact that merits further evaluation and study. Based on the results of this review, telehealth-based cancer rehabilitation interventions show promise to improve disability for cancer patients. In light of the cited limitations, how should the field move forward? Widening the patient populations studied building the evidence base for interventions prior to primary cancer treatment, and across multiple stages of the cancer trajectory, including end of life are necessary. Patient preferences, satisfaction, and outcomes with all telehealth modalities including low-tech options such as telephones should be explored. In addition, determining which therapies are most efficacious in telehealth modalities and which patients will benefit from specific therapies is of utmost importance. Consensus around appropriate measures is needed to be able to build the body of evidence. Lastly, assessing feasibility and translation potential must be addressed via implementation science methods. It is essential to conduct pragmatic trials, in order to know how to best meet the needs of cancer survivors. For future intervention research, it will be imperative to recruit and involve representative study samples related to race/ethnicity, socioeconomic status, and technology literacy to enhance generalizability of study findings to real-world settings. The questions are there; it is our mission to build the evidence.

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Data availability The de-identified transcriptions and dataset analyzed in the current study are available upon request to the corresponding author.

Declarations

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

Conflict of interest Drs. Pergolotti and Covington, and Tiffany Kendig report personal fees from Select Medical, ReVital Cancer Rehab outside the submitted work. Julie K. Silver has participated in research funded by the Binational Scientific Foundation and is a venture partner for Third Culture Capital outside of the work submitted. Aneesha Virani receives salary for full-time employment at Northside Hospital for work outside of submitted work. Aneesha Virani reports participating in research funded by the American Speech & Hearing Foundation for work outside of this project. Grace Campbell reports funding from the National Institute of Disability, Independent Living, and Rehabilitation Research. Kathleen D. Lyons reports participating in research funded by the National Cancer Institute for work outside of this project. All other authors declare no competing interests.

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