Telemedicine Applications for Cancer Rehabilitation: A Scoping Review

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Telemedicine Applications for Cancer Rehabilitation: A Scoping Review

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Abstract

Background: Cancer is a significant public health issue worldwide. Treatments such as surgery, chemotherapy, and radiation therapy often cause psychological and physiological side effects, affecting patients' ability to function and their quality of life. Physical activity is a crucial component of cancer rehabilitation, improving physical function, quality of life, and reducing cancer-related fatigue. However, many patients face barriers to accessing cancer rehabilitation due to socioeconomic factors, transportation issues, and time constraints. Telerehabilitation, can potentially overcome these barriers by delivering rehabilitation remotely

Objective: To identify how telemedicine is used for rehabilitation of patients with cancer.

Methods: Randomized Controlled Trials (RCTs) comprised 47.6% of the studies, with feasibility studies at 33.3% and usability studies at 19.0%. Most studies had sample sizes of 50 or fewer (57.1%). Participants were generally aged 65 or younger (81.0%), with a balanced gender distribution. Organ-specific cancers were the focus of 66.7% of the studies, while 28.6% included post-treatment patients. Web-based systems were the most used technology (61.9%), followed by mobile applications (23.8%) and phone call/SMS-based systems (42.9%). Exercise programs were mainly home-based (90.5%) and included aerobic (90.5%), resistance (61.9%), and flexibility training (33.3%). Outcomes included improvements in functional capacity, cognitive functioning, and quality of life (47.6%); reductions in pain and hospital length of stay; and enhancements in fatigue, physical and emotional well-being, and anxiety. Positive effects on feasibility (14.3%), acceptability (38.1%), and cost-effectiveness (9.5%) were also noted. Functional outcomes were frequently assessed (71.4%), with tools like the 6-Minute Walk Test and grip strength tests.

Results: Initially 37 studies were found but only 26 were considered for inclusion on this study. After a detailed analysis, 21 studies were included for this scoping review. Most of the studies concluded that telehealth system based on physical exercise were effective to improve function, quality of life, pain, satisfaction and muscle strength.

Conclusions: Telerehabilitation for cancer patients is beneficial and feasible, with diverse approaches in study design, technologies, exercises, and outcomes. Future research should focus on developing standardized methodologies, incorporating objective measures, and exploring emerging technologies like virtual reality and artificial intelligence to optimize telerehabilitation interventions. Addressing these areas can enhance clinical practice and improve outcomes for patients undergoing remote rehabilitation.

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Telemedicine Applications for Cancer Rehabilitation: A Scoping Review

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Abstract

Background: Cancer is a significant public health issue worldwide. Treatments such as surgery, chemotherapy, and radiation therapy often cause psychological and physiological side effects, affecting patients' ability to function and their quality of life. Physical activity is crucial to cancer rehabilitation, improving physical function and quality of life and reducing cancer-related fatigue. However, many patients face barriers to accessing cancer rehabilitation due to socioeconomic factors, transportation issues, and time constraints. Telerehabilitation can potentially overcome these barriers by delivering rehabilitation remotely.
Objective: To identify how telemedicine is used for the rehabilitation of patients with cancer.
Methods: This scoping review followed recognized frameworks. We conducted an electronic literature search on PubMed for studies published between January 2015 and May 2023. Inclusion criteria were studies reporting physical therapy telerehabilitation interventions for cancer patients, including randomized and non-randomized controlled trials, feasibility studies, and usability studies. Twenty-one studies met the criteria and were included in the final review.
Results: Our search yielded 37 articles, with 21 included in the final review. Randomized Controlled Trials comprised 47.6% (10/21) of the studies, with feasibility studies at 33.3% (7/21) and usability studies at 19.0% (4/21). Sample sizes were typically 50 or fewer participants in 57.1% (12/21) of the reports. Participants were generally aged 65 or younger (81.0%, 17/21), with a balanced gender distribution. Organ-specific cancers were the focus of 66.7% (14/21) of the articles, while 28.6% (6/21) included post-treatment patients. Web-based systems were the most used technology (61.9%, 13/21), followed by phone call/SMS-based systems (42.9%, 9/21) and mobile applications (23.8%, 5/21). Exercise programs were mainly home-based (90.5%, 19/21) and included aerobic (90.5%, 19/21), resistance (61.9%, 13/21), and flexibility training (33.3%, 7/21). Outcomes included improvements in functional capacity, cognitive functioning, and quality of life (47.6%, 10/21); reductions in pain and hospital length of stay; and enhancements in fatigue, physical and emotional well-being, and anxiety. Positive effects on feasibility (14.3%, 3/21), acceptability (38.1%, 8/21), and cost-effectiveness (9.5%, 2/21) were also noted. Functional outcomes were frequently assessed (71.4%, 19/21) with tools like the 6-Minute Walk Test and grip strength tests.
Conclusions: Telerehabilitation for cancer patients is beneficial and feasible, with diverse approaches in study design, technologies, exercises, and outcomes. Future research should focus on developing standardized methodologies, incorporating objective measures, and exploring emerging technologies like virtual reality, wearable or non-contact sensors, and artificial intelligence to optimize telerehabilitation interventions. Addressing these areas can enhance clinical practice and improve outcomes for remote rehabilitation patients.

Keywords: Telerehabilitation; Telemedicine; Rehabilitation; Cancer; Exercise; Physical Therapy

Introduction

Cancer is a worldwide public health problem and is the second leading cause of death in the United

States [1]. Treatments for cancer, such as surgery, chemotherapy, radiation therapy, and hormone therapy, often result in psychological and physiological sequelae and side effects that interfere with treatment completion, the ability to function and perform essential daily activities, and quality of life (QoL) [2]. Physical activity is an essential component of cancer rehabilitation and effectively reduces the burden of several specific cancers, including benefits related to physical function, QoL, and cancer-related fatigue [3].

The American College of Sports Medicine concluded that exercise training is safe during and after cancer treatments and improves the QoL in several cancer survivor groups [3]. Based on these findings, individualized and personalized programs are needed for cancer patients depending on the type of cancer, stage of the disease, and patient goals to avoid inactivity, disability, and worsening of their QoL. Rehabilitation is a standard part of cancer care and can have the potential to reduce the burden on the healthcare system [4].

Unfortunately, many patients do not have access to all the cancer rehabilitation therapy due to problems related to social economics, transportation, and several other factors that impact the treatment, like work, costs, and time [7,8]. All these factors can seriously impact the patient's access to cancer rehabilitation services in medical facilities. Conversely, technology has been growing, and treatment nowadays can be delivered to patients without the need for a face-to-face consultation [9]. This convergence of circumstances has led to the emergence of telerehabilitation, a subfield of telemedicine that utilizes information and communication technologies (ITs) to develop systems capable of managing and delivering rehabilitation remotely and has been suggested as one mechanism that can reduce some barriers to accessing and providing rehabilitation [10].

Telerehabilitation has been implemented across various diseases with promising results [11–17] and were considered highly cost-effective [5,6]. Nonetheless, there is a noticeable shortage of studies evaluating the use of physical therapy in telerehabilitation for cancer patients broadly. A review of reviews on telemedicine and digital health in cancer patients did not uncover any documents related explicitly to rehabilitation [18]. Furthermore, the available literature reviews tend to focus on specific types of cancer [19–21], lack a systematic approach to guide the review process [22–24], target pediatric populations [25], or focus exclusively on cognitive or behavioral rehabilitation [26].

For these reasons, this scoping review aimed to identify studies regarding physical therapy telerehabilitation for cancer survivors and understand the technology used, exercises, and outcomes of this type of treatment that has the potential to grow.

Methods

This scoping review was conducted using the methodological framework of Arksey and O'Malley [27], with five major steps:

1. Identify research question
2. Identify relevant studies
3. Evaluate and select studies to be included
4. Chart the data
5. Collect, summarize, and report the results

We report this study following the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews) 2020 guidelines [28] (Multimedia Appendix 1). The protocol was registered on Open Science Framework [29].

Research question

Based on our aim, we formulated the following research question: “How are telemedicine approaches used for cancer rehabilitation?”.

Search strategy

An electronic literature search was conducted using the PubMed database to identify relevant studies for inclusion in this scoping review. The following Boolean search terms were used: (telerehabilitation) AND (cancer) AND (“physical therapy” OR “exercise” OR “cancer rehabilitation”). No language restrictions were applied. The studies included were published between January 2015 and May 2023. This time frame was selected because, starting in 2015, global regulatory frameworks were established that promoted the use of telemedicine technologies. These frameworks provided standards and best practices, coinciding with increased adoption of ITs in the healthcare sector, thereby fostering research in this area. The literature search was reviewed and validated by an expert in telemedicine.

Study selection

We included studies that reported physical therapy exercises and telerehabilitation interventions for patients with cancer. Eligible designs included randomized and non-randomized controlled trials, controlled and non-controlled before-after studies, and feasibility and usability studies that reported the intervention treatment. Exclusion criteria comprise systematic review studies and meta-analysis, no physical therapy treatment mentioned, and studies with only psychological treatment. Two reviewers (PR and CMRR) conducted the selection process independently and in duplicate. Any disagreements were solved through discussion, and if consensus could not be reached, a third reviewer (JF) made the final decision.

Data extraction

One reviewer (CMRR) collected the data from the documents using a predefined collection form in an MS Excel spreadsheet. The other reviewer (PR) then double-checked the resulting form to ensure comprehensive data extraction. The data included in the study comprised the following: first author and year for each publication, type of study, specific design, sample size, social demographic characteristics (sex, age, race, and ethnicity), stage of cancer, and other special characteristics. Additionally, the specific technology used to deliver exercise programs or monitoring for each study, the type of exercise program, the description, duration, frequency, time per session, intensity of the program, and the monitoring of performance and the outcomes were charted. We synthesized findings by reporting frequencies and percentages for the abovementioned main characteristics. Furthermore, we chart the studies' geographic location, publication date, and type of study performed in a bubble plot.

Results

Selection process

Our research query provided 37 potential articles to be included in the study. After reviewing the title and abstract, we found 26 relevant documents to the research question. All these studies were then read in detail and reviewed, resulting in 21 articles to be included in the final study. This process is detailed in Figure 1.

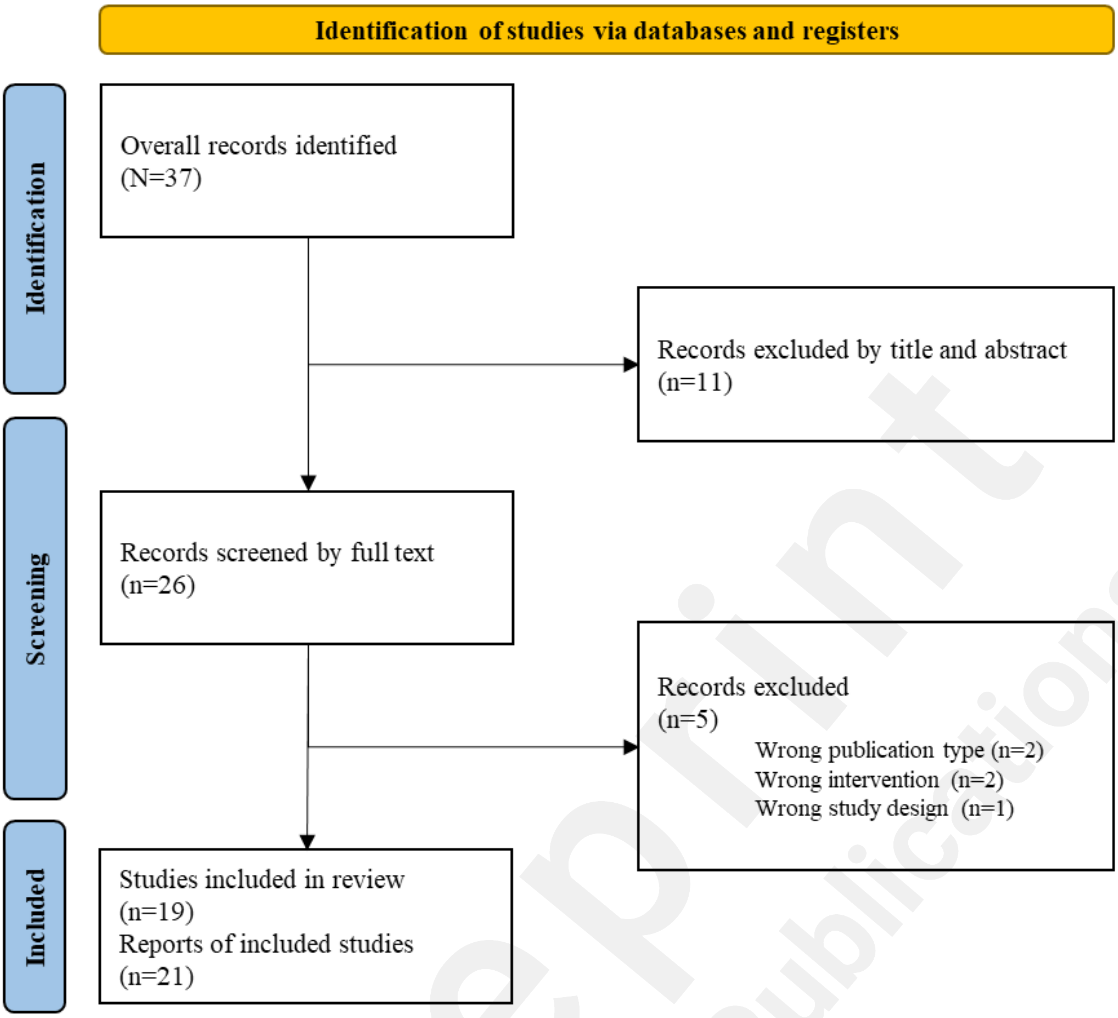

Figure 1. Study search and exclusion process.

General characteristics

Overall, 21 studies were included in this scoping review, spanning from 2015 to 2023 and representing a diverse range of countries and study designs. As illustrated in Figure 2, most of the articles were conducted in the United States (5/21, 24%), Spain (4/21, 19%), and South Korea (3/21, 14%). The distribution of study types across these regions shows a higher concentration of randomized clinical trials (RCTs) in the United States and Spain. In contrast, feasibility and usability studies were more evenly distributed across various countries.

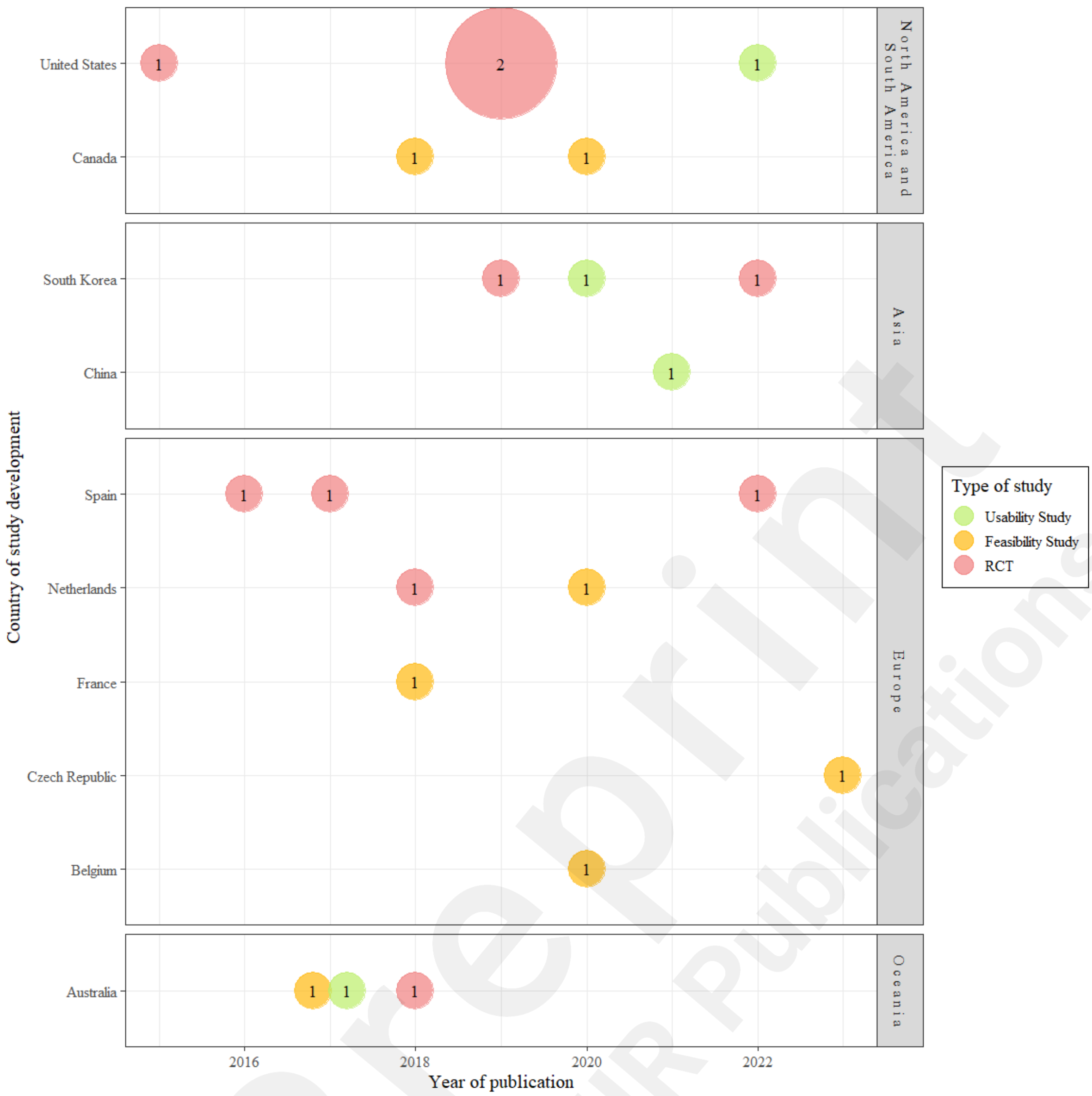

Figure 2. Studies by geographic location, type of study, and year of publication.

Table 1 shows that the most common type of study was the RCT, accounting for 48% (10/21) of the included studies. Feasibility studies constituted 33% (7/21) of the studies, while usability studies comprised the remaining 19% (4/21). The specific designs of these articles varied, with many adopting a prospective approach, and evaluations were often conducted at multiple time points, typically pre-and post-intervention. Regarding sample sizes, the total sample size for most studies was 50 or less, representing 57% (12/21) of the studies. Studies with sample sizes ranging from 51 to 100 comprised 33% (7/21), and only 10% (2/21) had more than 100 participants. When examining the sample size per group, 48% (10/21) of the studies had 30 or fewer participants per group, 43% (9/21) had between 31 and 50 participants per group, and only 10% (2/21) had more than 50 participants per group.

Table 1. Study Design and Participants Characteristics

Article	Type of Study	Specific design	Sample size	Participants socio-demographic characteristics	State of cancer, other special characteristics

Schwartz et al, 2015 [30]	RCT	Prospective, randomized, 2 arms, in parallel group, 2-time points evaluation (pre-post)	Total=50, T=25; C=25	Sex: 76.0% female (38/50). Age: mean=52.4 (SD 12.9)	Cancer under or after chemotherapy/radiotherapy
Galiano-Castillo et al, 2016 [31]	RCT	Prospective, randomized, 2 arms, in parallel group, 3-time points evaluation (pre-2 post)	Total=81, T=40, C=41	Sex: 100% female. Age: T mean=47.4 (SD 9.6), C mean=49.2 (SD 7.9)	Stage I–IIIA breast cancer after adjuvant therapy, without conditions that limit exercise
Collins et al, 2017 [32]	Feasibility Study	Prospective, non-randomized, 2 arms, in parallel group, multiple time points evaluation (each appointment)	Total=30, T= 15, C= 15	Sex: 33.3% female (10/30). Age: T mean=57 (Range 47–77), C mean=65 (Range 37–72)	Head and neck cancer under curative-intent chemotherapy/radiotherapy
Galiano-Castillo et al, 2017 [33]	RCT	Prospective, randomized, 2 arms, in parallel group, 2-time points evaluation (pre-post)	Total=81, T=40, C=41	Sex: 100% female. Age: T mean= 47.4 (SD 9.6), C mean= 49.2 (SD 7.9)	Stage I–IIIA breast cancer after adjuvant therapy and without conditions that limit physical exercise
Wall et al, 2017 [34]	Usability Study	Prospective, single-arm, 2 time point evaluation (pre-post)	Total=15	Sex: 100% male. Age: mean=58.7 (Range 46–70)	Oropharyngeal squamous cell carcinoma planned for curative-intent chemotherapy without physical impairments that limit exercise
Frensham et al, 2018 [35]	RCT	Prospective, randomized, 2 arms, in parallel group, 2-time points evaluation (pre-post)	Total=91, T=46, C=45	Sex: 51.6% female (47/31). Age: T mean=65.2, C mean=66.1. Race: Caucasian=87, Asian=2, ATSI=2	Cancer survivors who were not receiving treatment without contraindications for exercise
Gehring et al, 2018 [36]	RCT	Prospective, randomized, 2 arms, in parallel group, 2-time points evaluation (pre-post)	Total=34, T=23, C=11	Sex: 55.9% female (19/34). Age: T mean=48.0 (SD 9.4), C mean=48.0 (SD 11.9)	Stage II-III glioma, without contraindications for exercise
Vallerand et al, 2018 [37]	Feasibility Study	Prospective, randomized, 2 arms, in parallel group, 2-time points evaluation (pre-post)	Total= 51, T=26, C=25	Sex: 60.8% female (31/51). Age: mean=52.6 (SD 13.7)	Leukemia, non-Hodgkin or Hodgkin lymphoma, with the ability to perform exercise

Villaron et al, 2018 [38]	Feasibility Study	Prospective, randomized, 2 arms, in parallel group, 2-time points evaluation (pre-post)	Total=43, T=21, C=22	Sex: 72.1% female (31/43). Age: mean=49.7 (SD 13.7)	Cancer under chemotherapy or systemic treatment, with the ability to perform exercise
Cheville et al, 2019 [39]	RCT	Prospective, randomized, 3 arms, in parallel group, 2-time points evaluation (pre-post)	Total=516, T1=72, T2=72, C=72	Sex: 49.8% female (257/516). Age: mean=65.6 (SD 11.1). Race: White=492, Non-White=24. Ethnicity: Hispanic or Latino=28	Stage IIIC or IV solid or hematologic cancer and low to moderate functional impairment that limits ambulation
Ji et al, 2019 [40]	RCT	Prospective, randomized, 2 arms, in parallel group, 2-time points evaluation (pre-post)	Total=64, T=32, C=32	Sex: 29.7% female (19/64). Age: T mean=60.5 (SD 10.1), C mean=57.9 (SD 9.8)	Non-small cell lung cancer, ability to walk more than 150m in 6MWT
Longacre et al, 2019 [41]	RCT	Prospective, randomized, 3 arms, in parallel group, 2-time points evaluation (pre-post)	Tota=516, T1=172, T2=172, C=172	Sex: 49.8% female (257/516). Age: mean=65.6 (SD 11.1). Race: White=492, Non-White=24. Ethnicity: Hispanic or Latino=28	Stage IIIC or IV solid or hematologic cancer and low to moderate functional impairment that limits ambulation
Egmond et al, 2020 [42]	Feasibility Study	Ambispective, 2 arms, 2 time point evaluation (pre-post).	Total=45, T=15, C=30	Sex: 26.7% female (12/45). Age: T mean=62.8 (SD 6.9), C mean=60.3 (SD 7.0)	Esophageal or gastric cancer after surgery and with postoperative complications, with impairments that limit mobility, were assigned to in-person therapy
Kim et al, 2020 [43]	Usability Study	Prospective, single-arm, 3-time point evaluation (pre-during-post)	Total=31	Sex: 16.1% female (5/31). Age: mean=56.7 (SD 7.7)	Stage I-II hepatocellular carcinoma, who could walk independently for more than 30 min
MacDonald et al, 2020 [44]	Feasibility Study	Prospective, single-arm, 2 time point evaluation (pre-post)	Total=35	Sex: 62.9% female (22/35). Age: mean=55 (SD 15.9)	Cancer survivors with a moderate-high disability received clearance from a physiatrist to participate in exercise

Piraux et al, 2020 [45]	Feasibility Study	Prospective, single-arm, 2 time point evaluation (pre-post)	Total=23	Sex: 30.4% female (7/23). Age: mean=61.7 (SD 10.6)	Esophageal or gastric cancer planned for surgery without conditions that contraindicate or limit exercise
Zhou et al, 2021[46]	Usability Study	Cross-sectional, single-arm, 1 time point evaluation (post)	Total=15	Sex: 100% female. Age: mean=54.7 (SD 7.78)	Stage I-III breast cancer after surgery, able to perform whole-body physical activity
Finkelstein et al, 2022 [47]	Usability Study	Cross-sectional, single-arm, 1 time point evaluation (post)	Total=11	Sex: 100% male. Age: mean=68.1 (SD 11.2)	Metastatic urogenital cancer receiving outpatient care
Lozano-Lozano et al, 2022 [48]	RCT	Prospective, randomized, 2 arms, in parallel group, 2-time points evaluation (pre-post)	Total=80, T=40, C=40	Sex: 100% female. Age: T mean= 49.7 (SD 8.42), C mean=53.4 (SD 8.66)	Stage I–IIIA breast cancer, some range of ROM limitation, and overweight
Park et al, 2022 [49]	RCT	Prospective, randomized, 2 arms, in parallel group, 2-time points evaluation (pre-post)	Total=100, T=50, C=50	Sex: 100% female. Age: T mean=42.5 (SD 9.06), C mean=47.3 (SD 8.55)	Breast cancer after surgery, with limited ROM in the affected shoulder but able to perform exercise
Filakova et al, 2023 [50]	Feasibility Study	Prospective, single-arm, 2 time point evaluation (pre-post)	Total=11	Sex: 72.3% female (8/11). Age: mean=60.3 (SD 10)	Lymphoma after chemotherapy, with the ability to perform exercise

Note: RTC = Randomized controlled trial; T = total number of participants; C= control group; F= female; M= male; ATSI

Participants characteristics

Table 1 reveals that the gender distribution among the studies was varied. Only two studies (10%) included all men, whereas seven studies (33%) had more men than women. Similarly, seven studies (33.%) had more women than men, and five studies (24%) included all women participants. Most of the studies involved participants aged 65 or less, accounting for 81% (17/21) of the studies. Only 19% (4/21) of the studies included participants who were older than 65 years.

The studies encompassed a wide range of cancer types and stages of cancer treatment (See Table 1). Organ-specific cancers were the focus of 67% (14/21) of the studies, including breast cancer, head and neck cancer, lung cancer, and various others. The remaining 33% (7/21) of the studies did not specify the type of cancer, focusing instead on cancer survivors or patients undergoing chemotherapy or radiotherapy. Six studies (29%) included post-treatment participants, while three studies (14%) involved participants undergoing treatment. Two studies (10%) included participants before the start of treatment, and ten studies (48%) had unclear stages of treatment.

Technology used

As shown in Table 2, the articles included in this scoping review utilized various technologies to deliver exercise programs or monitor participants, highlighting the diverse approaches to telerehabilitation for cancer patients. Most studies (62%, 13/21) employed web-based systems, such as Retwise, e-CUIDATE, SwallowIT, etc., to facilitate patient and provider interactions. Mobile applications were used in 24% of the studies (5/21), with apps like Physitrack, Second Wind, and the BENECA mHealth app being notable examples.

Phone call or short message service (SMS)-based systems were utilized in 43% of the studies (9/21), either as standalone methods or in conjunction with other technologies. For instance, Vallerand et al. [37] and Villaron et al. [38] used phone calls and SMS, respectively, to deliver and monitor exercise programs. Additionally, medical devices were integrated into 24% of the studies (5/21), often paired with other technologies. Examples include pulse oximeters, pedometers, and heart rate (HR) monitor watches.

Immersive technologies, such as virtual reality (VR), were employed in 10% of the studies (2/21). These included systems like the Kinect motion capture via Xbox and other VR-based approaches.

The studies varied in the number of technologies employed. Approximately 48% of the studies used only one type of IT to deliver their programs. In contrast, 9 out of 21 studies (43%) utilized two types of IT, combining methods like web-based systems with phone calls or medical devices. A smaller portion, 10% (2/21), employed three types of IT.

Several studies combined different technologies to enhance the delivery and monitoring of exercise programs. For example, Ji et al. [40] used a combination of a mobile app (Elif breath), a wearable pulse oximeter, and a web-based system for providers. Similarly, MacDonald et al. [44] integrated a mobile app (Physitrack), a Fitbit device, and phone calls to provide comprehensive patient support. Other studies focused on leveraging the strengths of specific technologies. For instance, Egmond et al. [42] utilized the mobile app Physitrack for patient engagement, while Finkelstein et al. [47] employed the Home Automated Telemanagement website to facilitate patient interactions.

Table 2. Intervention characteristics.

Article	Technology used to deliver exercise programs or monitoring	Type of exercise program	Exercise program description	Duration, frequency, time per session, and intensity of the program	Monitoring of performance	Outcomes measured
Schwartz et al, 2015 [30]	Web-based system (Retwise website) for patient + pulse oximeter	In-person clinic-based rehabilitation + Self-directed home-based tailored exercise program	Aerobic and resistance training	12 wks, 3 - 4 sessions per wk, 20 min of aerobic exercise at an intensity of 60% to 70% of aerobic capacity, and 3 to 5 resistance exercises	Self-monitoring using digital tools and web-system	6MWT, 1-repetition maximum of lower and upper body strength

				with unclear time per session neither intensity.		
Galiano-Castillo et al, 2016 [31]	Web-based system (e-CUIDATE website) for patient and provider + phone call	Home-based Remote real-time guidance provided by CUIDATE Research staff	1) Warm-up, 2) resistance and aerobic exercise training, and 3) cool-down	8 wks, 3 sessions per wk, 90 min per session. Intensity and volume of exercise according to guidelines of the American College of Sports Medicine for cancer survivors	Remote asynchronous and synchronous monitoring via web system, videoconferencing, or phone calls, on-demand by CUIDATE research staff	Quality-of-Life, Brief Pain Inventory, Handgrip dynamometer, Isometric abdominal test, Back dynamometer, Multiple sit-to-stand test, and the Piper Fatigue Scale
Collins et al, 2017 [32]	Web-based system (unspecified website) for patient and provider	Home-based Remote real-time guidance provided by clinic staff	Rehabilitation of swallowing and communication function, nutritional management, and review of post-treatment symptoms.	8 mo, unclear frequency, neither time per session, and these were requested on-demand. Unclear intensity.	Unclear	Service outcomes, costs, and consumer satisfaction
Galiano-Castillo et al, 2017 [33]	Web-based system (e-CUIDATE website) for patient and provider + Phone calls	Web-system guided home-based tailored exercise program	1) Warm-up, 2) resistance and aerobic exercise training, and 3) cool-down	8 wks, 3 sessions per week, 90 min per session. Intensity and volume of exercise according to guidelines of the American College of Sports Medicine for cancer survivors	Remote asynchronous and synchronous monitoring via web system, videoconferencing, or phone calls, on-demand by CUIDATE research staff	6MWT; Auditory Consonant Trigrams and Trail Making b Test.
Wall et al, 2017 [34]	Web-based system (SwallowIT website) for patient and provider	Web-system guided home-based tailored exercise program	Swallowing exercises based on the 'Pharyngocise' protocol	6 wk, daily, 45 min per session. Unclear intensity.	Remote asynchronous monitoring after exercise via web system, unclear frequency by the speech pathologist	Perceptions were evaluated via structured questionnaires and phone interview patients' attitudes towards using SwallowIT (four

						questions); the functionality of the system (two questions); the efficacy of the system (four questions), and preferences for other service-delivery models (two questions).
Frensham et al, 2018 [35]	Web-based system (STRIDE website) for patient + pedometer	Self-directed home-based tailored exercise program	Individual target steps/ day program	Unclear	Self-monitoring via web system, daily	Measures of physiology, physical fitness, QoL, and 6MWT
Gehring et al, 2018 [36]	Web-based system (unspecified website) for patient and provider + HR monitor watch + Phone calls	Self-directed home-based tailored exercise program	The intervention comprised three home-based aerobic training sessions per wk for six months.	6 mo, 3 sessions per wk, unclear time per session. Intensity of 60-85% of maxHR	Remote asynchronous monitoring after exercise via the system weekly by the physiotherapist	Feasibility (Accrual, attrition, adherence, safety), satisfaction, patient-reported physical activity, VO2 peak and BMI
Vallerand et al, 2018 [37]	Phone call-based system for both patients and providers	Self-directed home-based regular progressing exercise program	Aerobic exercises	12 wks, unclear frequency, recommended 60min/wk to 300min/ wk time per session. Unclear intensity	Remote synchronous monitoring/coaching via phone call weekly by research staff	Self-reported aerobic exercise behavior, QoL, fatigue, and program satisfaction. Feasibility metrics (recruitment, adherence, adverse events, retention, follow-up, and acceptability metrics)
Villaron et al, 2018 [38]	Pedometer + SMS	Self-directed home-based standard exercise program	Walking program with a pedometer	8 wks, unclear frequency, time per session, neither intensity	Remote asynchronous coaching, weekly by research staff	Level of physical activity (pedometer). Fatigue (MFI-20); EORTC-QLQ-C30
Cheville et al, 2019 [39]	Web-based system (unspecified website) for both patient and providers+ pedometer+	Self-directed home-based tailored exercise program	The physical therapists instructed patients in an incremental pedometer-	6 mo, recommended at least 4 sessions per wk, unclear time per session,	Remote synchronous monitoring after exercise via phone call, on demand by physiotherapist	Activity Measure (computer adaptive test), pain interference and average

	Phone call		based walking program and a resistive exercise program	neither intensity	Remote asynchronous monitoring via web system, weekly by physiotherapist	intensity (Brief Pain Inventory), and QoL (EQ-5D-3L)
Ji et al, 2019 [40]	Mobile app (elif breath) for patients + Wearable pulse oximeter + Web-based system for providers	Mobile app-guided home-based tailored or fixed exercise program	Walking distance exercise program mainly, and resistance exercises guidance videos.	12 wks, unclear frequency, time per session, neither intensity.	Remote asynchronous monitoring after exercise via web system, unclear frequency by lung cancer specialists and nurses	6MWT, Dyspnea [mMRC]; QoL (EQ-5D) and service satisfaction
Longacre et al, 2019 [41]	Web-based system (unspecified website) for both patient and providers+ pedometer+ Phone call	Self-directed home-based tailored exercise program	Pedometer-based walking program and a resistive exercise program	6 mo, recommended at least 4 sessions per wk, unclear time per session, neither intensity	Remote synchronous monitoring after exercise via phone call, on demand by physiotherapist Remote asynchronous monitoring via web system, weekly by physiotherapist	QoL (EQ-5D-3L), Intervention costs
Egmond et al, 2020 [42]	Mobile app (Physitrack) for patients	Web-system guided home-based tailored exercise program	Muscle strength, coordination, range of joint motion, and stamina	12 wk, at least 2 sessions per wk, unclear time per session. The intensity and frequency of the functional exercises were determined according to the guidelines of the American College of Sports Medicine	Remote synchronous monitoring after exercise via phone call, SMS, or videoconference weekly by physiotherapist	Willingness, adherence, refusal rate, treatment duration, occurrence of adverse events, patient satisfaction. Musculoskeletal and cardiovascular functions and activities
Kim et al, 2020 [43]	Mobile app (Second Wind) for patients and providers + IoT track device (HR, steps, calorie expenditure, exercise time)	Mobile app-guided home-based tailored exercise program	Warm-up, stretching, aerobic, and muscle-strengthening exercises for the upper and lower extremities	12 wks, unclear frequency, neither time per session. Intensity and target heart rate for the aerobic	Self-monitoring using digital tools and on-demand remote asynchronous monitoring by the study coordinator	6MWT, grip strength test, 30-second chair stand test, IPAQ-SF; Body composition, biochemical profiles; Quality-of-Life (C30)

				exercise were set from the results of the 6-minute walk test (6MWT)		
MacDonald et al, 2020 [44]	Mobile app (Physitrack) for patients and providers + Fitbit + Phone calls	Mobile app-guided home-based tailored exercise program	Aerobic exercise for 150 min per week, 2 to 3 days of resistance training, and routine large muscle group flexibility training	8 wks, 2-3 sessions per wk, unclear time per session, neither intensity	Self-monitoring via mobile health app and remote asynchronous monitoring via web system and feedback provided via phone call weekly by kinesiologist	Feasibility, acceptability. Physical symptoms, social functioning, distress, physical activity, work function, and physiological factors
Piraux et al, 2020 [45]	Web-based system (Virtuagym website) for patients and provider + Phone calls	Digital tool-guided home-based tailored exercise program	Tele-prehabilitation, including aerobic, resistance, and inspiratory muscle training	2-4 wks, 3-5 sessions per wk, 75 min per session Intensity of 65–74% of maximum HR for aerobic exercises	Remote synchronous monitoring after exercise via phone call by physiotherapist	Feasibility (recruitment rate, retention rate, attendance to exercise sessions, exercise-related adverse events, and patient satisfaction), 6MWT, fatigue, QoL, anxiety and depression
Zhou et al, 2021[46]	Virtual Reality-based system	By design, digital tool guided home-based tailored program	1) Fist clenching, 2) Wrist twisting, 3) Elbow bending, 4) Lifting, 5) Shoulder circling, 6) Ear touching, 7) Wall climbing, 8) Back handing, 9) Head holding, 10) Abduction	1 session	Unclear	General information questionnaire; Usability surveys: System Usability Scale (SUS); SSQ; PQ
Finkelstein et al, 2022 [47]	Web-based system (HAT system website) for patients	By design, web-system guided home-based tailored program	Individuality: Specific exercises based on patients' needs	1 session	Remote asynchronous monitoring after exercise via system by the health provider	Surveys: socio-demographic form; the Rapid Estimate of Adult Literacy in Medicine (REALM); SUS; Semi-structured

						qualitative exit interview
Lozano-Lozano et al, 2022 [48]	Mobile app (BENECA mhealth app) for patients	In-person clinic-based rehabilitation	Individualized AROM session	8 wks, 3 sessions per wk, 75 - 95 min per session. Unclear intensity.	Self-monitoring via mobile health app	QoL (EORT QLQ-C30; EORT QLQ-BR23; EORT QLQ-C30); Disabilities of the Arm, Shoulder, and Hand (DASH), a self-reported questionnaire that measures symptoms and physical function (disability) for any upper-limb region
Park et al, 2022 [49]	Virtual Reality-based system (Kinnect motion capture via XBoX (UINCARE Home+rehabilitation system))	Digital tool-guided home-based tailored exercise program	Each exercise level was composed of warm-up (deep breathing + trunk twist), main workouts (different degrees of motion and variations of passive or active flexion, rotation, and abduction exercises with or without dumbbells were used), and cool-down (deep breathing) components. The exercise level was determined according to the results obtained over the first 4 weeks. Passive and active ROM of shoulder exercises were included.	12 wks, daily, unclear time per session, neither intensity	Remote asynchronous monitoring after exercise via a system by the physician	ROM of the affected shoulder, pain in the affected shoulder (Numerical Rating Scale [NRS]), functional outcomes (Quick DASH score), and QoL (Functional Assessment of Cancer Therapy-Breast [FACT-B] and EuroQoL 5-Dimension 5-Level [EQ-5D-5L]

Filakova et al, 2023 [50]	Web-based system (PolarFlow website) for patient + HR monitor sync to website + Phone call	Self-directed home-based tailored exercise program	Modality of walking, Nordic walking, or cycling dependent on patient preference	12 wks, 3 sessions per wk, 30-50 min per session. Intensity of 60 to 85% HRmax and 11 to 13 on the Borg rating of RPE	Remote synchronous monitoring after exercise via phone call weekly by the physiotherapist Remote asynchronous monitoring via web system, unclear frequency by physiotherapist	Weight, Body composition, Cardiopulmonary exercise test

Note: 6MWT = Six-minute walking test; VO2 peak = peak oxygen uptake; BMI = body mass index.

Exercise program details

Most physical rehabilitation programs (33%, 7/21) were self-directed, home-based tailored exercise programs, where patients followed individualized exercise plans independently. Web-system-guided programs accounted for 24% of the studies (5/21), utilizing digital platforms to provide real-time or asynchronous guidance. Mobile app-guided programs comprised 14% of the studies (3/21), leveraging mobile health applications to deliver and monitor exercise routines. Additionally, 14% (3/21) of the programs were directly guided by health providers, and digital tools guided 10% (2/21).

Most exercise programs (19/21, 90%) were home-based, enabling patients to perform their routines in a familiar environment. Only one study (5%) included clinic-based rehabilitation, and another (5%) combined home and clinic-based exercises. The types of exercises predominantly included aerobic (19/21, 90%), resistance (13/21, 62%), and flexibility training (7/21, 33%). Two studies (10%) focused explicitly on swallowing exercises, addressing particular needs of patients with oropharyngeal cancer.

The duration of the exercise programs varied, with 11 out of 21 (52%) of the articles reporting interventions extending beyond two months and 7 (33%) lasting two months or less. The frequency of exercise sessions was less than daily in 48% (10/21) of the studies, while daily exercise was prescribed in 14% (3/21). However, the exercise frequency was unclear in 29% of the studies (6/21). The time per session was varied, with 24% of the studies (5/21) specifying sessions of one hour or less and 10% (2/21) indicating sessions longer than one hour. The time per session was unclear in 57% of the studies (12/21). The exercise intensity was explicitly defined in 38% of the studies (8/21), while it remained unclear in 52% (11/21).

Monitoring methods were diverse, reflecting the integration of various technologies and approaches. Remote asynchronous monitoring was common, with many studies using web systems, phone calls, or mobile apps to track patient progress. For instance, Galiano-Castillo et al. (2016, 2017) utilized both synchronous and asynchronous monitoring via web systems and videoconferencing, while MacDonald et al. (2020) combined self-monitoring via a mobile health app with weekly feedback from a kinesiologist. Self-monitoring was also a key component in several programs. Schwartz et al. (2015) and Kim et al. (2020) implemented self-monitoring using digital tools, allowing patients to track their own progress and report it to healthcare providers as needed.

Outcomes Measured

The outcomes measured in the studies included in this scoping review highlight the multifaceted approach to assessing the effectiveness and feasibility of physical telerehabilitation programs for cancer patients. These outcomes can be broadly categorized into QoL, usability, feasibility, and functional outcomes, with some studies measuring additional specific outcomes.

QoL was a key outcome measured in 48% of the studies (10/21). Instruments such as the EQ-5D-3L, Brief Pain Inventory, Piper Fatigue Scale, and various cancer-specific QoL questionnaires like EORTC QLQ-C30 were commonly used. For instance, Galiano-Castillo et al. [31] and Cheville et al. [39] utilized these tools to evaluate participants' overall well-being and health status, while Egmond et al. [42] assessed musculoskeletal and cardiovascular functions and activities alongside patient satisfaction.

Usability outcomes were assessed in 38% of the studies (9/21), focusing on the practicality and user-friendliness of the telerehabilitation interventions. Studies like those by Wall et al. [34] and Finkelstein et al. [47] employed structured questionnaires and surveys, including the SUS, to gather feedback on participants' experiences and satisfaction with the technological platforms used.

Feasibility outcomes, measured in 14% of the studies (3/21), included metrics such as recruitment rates, adherence, retention, and safety. Studies by Gehring et al. [36] and MacDonald et al. [44] focused on these aspects to determine the practicality and acceptability of the interventions.

Functional outcomes were the most frequently assessed, with 71% of the studies (15/21) measuring various aspects of physical performance. Commonly used measures included the 6MWT, grip strength tests, and body composition assessments. Studies like those by Schwartz et al. [30] and Kim et al. [43] employed these tests to evaluate improvements in physical fitness and functional capacity. Additionally, specific functional outcomes related to cancer treatment, such as the DASH questionnaire used by Lozano-Lozano et al. [48], were also assessed.

Other outcomes measured in 33% (7/21) of the studies included service outcomes, costs, and consumer satisfaction, as seen in the study by Collins et al. [32]. Additionally, some studies measured unique outcomes specific to the intervention or population, such as weight and body composition, as in the study by Filakova et al. [50].

Most studies (11/21, 52.4%) measured two outcomes, integrating assessments of functional performance and QoL or usability. For example, Ji et al. [40] evaluated 6MWT, dyspnea, QoL, and service satisfaction, providing a comprehensive overview of the intervention's impact. A smaller portion of studies (23.8%) measured three or more types of outcomes, offering a detailed evaluation across multiple dimensions.

Discussion

Principal Results and comparison with other studies

This scoping review aimed to explore the existing telerehabilitation studies for patients with cancer. We included 21 papers that met our criteria. The major findings indicated that physical therapy delivered via telehealth for cancer patients can improve functional capacity, cognitive functioning, QoL [33,48]; reduce pain and hospital length of stay [39]; and improvement of fatigue, physical well-being, emotional well-being, and anxiety [45]. Additionally, improvements in absolute VO2 peak and BMI [36,50]; handgrip strength of affected and non-affected sides; abdominal, back, and lower body strength [31]; physical fitness, systolic blood pressure, diastolic blood pressure, waist girth, mental health, social functioning, general health [35]; and strength and endurance were observed [30]. Positive effects on feasibility [32,36,37,42,44–47]; acceptability [30,34,44] and cost-effectiveness were also noted [41].

These findings align with previous studies demonstrating the feasibility of physiotherapy with telerehabilitation. For instance, a systematic review with meta-analysis by Egmond et al. showed that telerehabilitation in surgical populations is feasible and can enhance QoL [51]. Given that the effectiveness of telerehabilitation is at least equal to usual care for physical outcomes, it presents a viable alternative for physical therapy [51]. The improvement of QoL was a major outcome across most studies; similarly, a systematic review by Bártolo et al. found a trend towards improved QoL among cancer patients who were exposed to telecare interventions [52].

This review included ten randomized controlled trials, seven feasibility studies, and four usability studies. Consequently, there is a need for more robust studies on cancer telerehabilitation, with greater uniformity in clinical trial reports. Developing clinical practice guidelines and integrating exercise and rehabilitation services into the cancer care delivery system are essential steps forward [53].

Research indicates that exercise is advantageous before, during, and after cancer treatment, applicable to all cancer types and various cancer-related impairments [53]. Engaging in moderate-to-vigorous exercise is particularly effective for enhancing physical function and alleviating cancer-related impairments. Supervised exercise programs have been shown to provide greater benefits than unsupervised ones, with serious adverse events being rare [53]. In our review, the exercises included aerobic routines, resistance training, swallowing exercises, and walking programs, all supervised via web-based systems, mobile apps, and telephone calls.

However, our review also reveals gaps in the current literature, particularly in the underreporting of exercise intensity and frequency, which are crucial for understanding the full impact of these programs. Future studies should provide more detailed descriptions of these parameters to enhance the reproducibility and comparability of findings. Moreover, while our review indicates overall positive outcomes, the variability in study designs and sample sizes suggests a need for more standardized methodologies to strengthen the evidence base.

A recent systematic review on the effectiveness of exercise-based telerehabilitation for cancer patients demonstrated significant improvements in cardiorespiratory fitness (SMD = 0.34, 95% CI 0.20, 0.49) and physical activity (SMD = 0.34, 95% CI 0.17, 0.51) [54]. However, the review did not find significant changes in other outcomes, such as QoL, fatigue, or mental health. These findings underscore specific areas of measurable improvement while highlighting gaps in other critical domains of patient well-being. Complimentary, our scoping review uniquely contributes to this field by offering a more comprehensive examination of telerehabilitation interventions. Unlike the systematic review, we included quasi-experimental studies and assessed feasibility and usability outcomes, providing a broader understanding of the preliminary research landscape. This inclusive approach not only explores the outcomes evaluated by the interventions but also evaluates their practical implementation and user experience. By detailing the various components and methodologies of telerehabilitation programs, our review extends the current knowledge base, emphasizing the multifaceted benefits and challenges of implementing these interventions for cancer patients. This holistic perspective is crucial for developing more effective and user-centered telerehabilitation strategies in oncology care.

We only found two articles using immersive technologies, such as VR, with one RCT reporting beneficial outcomes for patients. This finding aligns with recent evidence suggesting that VR is feasible for telerehabilitation in other chronic conditions, such as COPD and orthopedic diseases [55,56]. Given the recent increase in research on immersive technologies, VR in telerehabilitation is a promising area for future exploration [57].

Another noteworthy aspect of our review is that only five articles referenced the use of wearable devices to provide patients with objective measures of progress during their rehabilitation. Although limited in our review, wearable devices offer significant potential for remote monitoring. A systematic review found that wearables significantly increased physical activity levels in patients with cardiovascular diseases [58]. This suggests that wearable or non-contact sensors [52] could be effectively integrated into telerehabilitation programs to enhance patient monitoring and outcomes.

Lastly, using artificial intelligence (AI) in telerehabilitation is a technological trend worth observing. Our review did not find any articles referencing the use of AI. Still, the recent exponential growth in AI applications in healthcare suggests this trend could be explored in future studies. AI has the potential to significantly impact telerehabilitation by providing personalized and adaptive interventions based on patient data [59,60]. Exploring AI integration could open new avenues for improving the effectiveness and efficiency of telerehabilitation programs.

Limitations

This scoping review has some limitations that should be acknowledged. First, the heterogeneity of the included studies presents a challenge in synthesizing the findings. The studies varied widely in terms of their design, participant characteristics, types of cancer, interventions, and outcomes measured. This variability makes it difficult to draw definitive conclusions about the overall effectiveness of telerehabilitation for cancer patients. Despite this, the diversity of studies also highlights the flexibility and adaptability of telerehabilitation interventions, which is a strength in addressing the varied needs of cancer patients. Second, the reliance on self-reported data for some outcomes may introduce reporting bias and affect the accuracy of the findings. While self-reported measures are valuable for assessing subjective outcomes like QoL, they are susceptible to inaccuracies. Objective measures such as wearable devices to monitor physical activity and physiological parameters can help validate self-reported data and provide a more comprehensive assessment. Third, many of the included studies had relatively small sample sizes, limiting the statistical power and generalizability of the results. Conducting larger, multi-center studies would increase sample sizes and enhance the representativeness of the findings, providing more robust statistical power to detect significant effects. Fourth, the technological variability across studies, with different platforms used for delivering and monitoring telerehabilitation, adds another layer of complexity and affects the comparability of the results. Standardizing the technological platforms used in interventions could reduce variability and improve comparability. Fifth, our review did not include a formal risk of bias evaluation, which could affect the reliability of our conclusions. While we included randomized controlled trials and quasi-experimental studies, which generally have higher quality, and ensured that all studies came from peer-reviewed journals, future studies should incorporate a formal risk of bias assessment to further enhance the rigor and reliability of the findings. Finally, we acknowledge that this is a rapidly evolving field, and more recent studies or those published before 2015 may have been missed. Moreover, while we conducted a thorough search, the exclusive use of PubMed as the database and the specific term "telerehabilitation" may have limited the identification of some relevant papers. The term "telerehabilitation" is relatively recent and might not be uniformly used across different regions and research contexts, potentially omitting some studies that use alternative terminology. Future reviews could benefit from including multiple databases and a broader range of search terms to capture the full scope of the literature. Despite these limitations, our review provides a comprehensive overview of the current state of research in telerehabilitation for cancer patients, highlighting important trends and gaps that can inform future studies and clinical practice.

Conclusions

This scoping review demonstrates that telerehabilitation exercises for cancer patients are beneficial and feasible, with various approaches used in study design, technology, exercises, and outcomes. The evidence indicates that telerehabilitation can improve functional capacity, cognitive functioning, QoL, and other health metrics while being cost-effective and acceptable to patients. However, the review also highlights significant variability in study designs and a need for more detailed reporting on exercise intensity and frequency. Future research should focus on developing standardized methodologies, incorporating objective measures, and exploring emerging technologies such as VR and AI to optimize telerehabilitation interventions for cancer patients. By addressing these areas, we can enhance clinical practice and improve outcomes for remote rehabilitation patients.

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Conflicts of Interest

None declared.

Abbreviations

6MWT: 6-minute walk test
AI: artificial intelligence
BMI: body mass index
COPD: chronic obstructive pulmonary disease
IT: information and communication technology
QoL: quality of life
RCT: randomized clinical trial
SMS: short message service
SMD: standardized mean difference.
SUS: System Usability Scale.
VR: virtual reality

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Supplementary Files

Figures

Untitled.

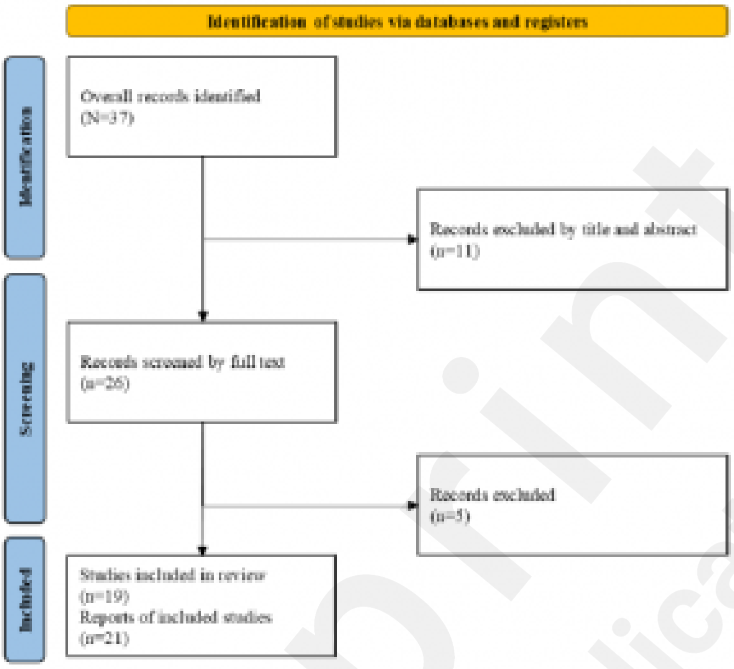

Figure 1. Study search and exclusion process.

Untitled.


United States
Canada
South Korea
China
Spain
Netherlands
France
Czech Republic
Belgium
Australia
Country of study development
2016
2018
2020
2022
Year of publication
North America and South America
Asia
Europe
Oceania
Type of study
Usability Study
Feasibility Study
RCT

CONSORT (or other) checklists

PRISMA-ScR checklist.
URL: http://asset.jmir.pub/assets/95f88742e59938f26ddb072982641494.pdf