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REVIEW ARTICLE

Community-based exercise programs for cancer survivors: a scoping review of practice-based evidence

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Abstract

Purpose Based on randomized controlled trials, exercise is an efficacious strategy to improve quality of life (QOL) among cancer survivors. However, the effectiveness of exercise programs to improve QOL in real-world settings is unknown, as are factors related to external validity. This hinders dissemination and scalability. This scoping review synthesized published research on community-based exercise programs for cancer survivors and reported on the *r*each, *e*ffectiveness, *a*doption, *i*mplementation, and *m*aintenance (RE-AIM).

Methods A systematic literature search identified community-based exercise programs for adult cancer survivors (1980–March 2018), that met the following inclusion criteria: at least one face-to-face exercise session, the primary aim of program evaluation (i.e., feasibility/effectiveness), and pre/post measure of QOL. Data were coded using the RE-AIM framework. The effect size was calculated for overall QOL.

Results Electronic database search yielded 553 articles; 31 studies describing unique programs were included for review. All studies described at least one element of implementation and most (80.6%) reported a significant ($p < .05$) improvement in at least one subscale, or total QOL. Few studies reported on indicators of reach (16.1%), adoption (6.5%), individual (16.1%), or system-level maintenance (32.3%).

Conclusions Community-based exercise programs are effective for improving QOL in adult cancer survivors. Recommendations are provided to improve reporting across RE-AIM dimensions, which is an important step to enhance the scalability of programs and thus, the potential for exercise to be fully integrated into system-level standard care for cancer survivors.

Implications for Cancer survivors Community-based exercise programs are a resource to improve QOL for adult cancer survivors.

Keywords Cancer survivors · Exercise · Program evaluation · Quality of life · RE-AIM · Scoping study

Introduction

Improvements in the detection and treatment of cancer have resulted in an estimated 15.5 million cancer survivors living in the USA [1]. Anti-cancer treatments are associated with negative side effects, leading to detriments in quality of life (QOL) [2, 3]. Exercise is recommended to ameliorate these side effects, and systematic reviews and meta-analyses of randomized controlled trials (RCT) have established the efficacy of exercise interventions for improving cancer survivors' QOL [4–7]. Often, exercise interventions are time and resource-intensive and include homogenous samples (e.g., excluding those with comorbidities, certain cancer types, and older adults), and ignore contextual factors such as implementation resources and cost. These constraints limit the generalization of RCTs to non-research settings.

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It has been recommended that exercise and cancer survivorship research use more generalizable study designs [8]. Thus, several community-based exercise programs for cancer survivors have been implemented, and results published. In contrast to highly controlled, hypothesis-driven RCTs, the primary goals of a community-based exercise program are to deliver an intervention to a wide audience and improve some domain(s) of health or well-being. Three previous reviews have synthesized the available literature evaluating community-based exercise programs for cancer survivors and concluded that these programs generally resulted in positive outcomes for participants [9–11]. Yet, none of these reviews examined program effects on QOL or evaluated contextual factors related to external validity (i.e., generalizability outside of study context), such as program design or implementation. Furthermore, previous reviews were not comprehensive/systematic [9, 10] or were limited by the exclusion of non-RCT study designs [11]. This has led to a paucity of knowledge regarding the implementation logistics, context, and generalizability of community-based programs, thereby limiting scalability and the potential for exercise to be fully integrated into system-level standard care for cancer survivors [8]. It is essential for research to progress beyond the controlled laboratory environment, to the evaluation of individual exercise programs to generate *practice-based evidence* (i.e., high-quality scientific evidence that is cultivated and analyzed in the real-world settings first) that can drive the translation of research findings into practice and policy [12, 13].

Dissemination and implementation (D & I) frameworks evaluate the "how" and "why" needed to enhance evidence-based program delivery [14]. Applying a D & I framework to evaluate existing community-based exercise programs for cancer survivors will expand the evidence for improved scalability of effective programs [8]. RE-AIM (*r*each, *e*fficacy/effectiveness, *a*doption, *i*mplementation, and *m*aintenance) is a D & I framework for systematic program evaluation, designed to enhance the quality, speed, and public health impact of programs in the real-world settings (www.re-aim.org) [15]. Using the RE-AIM framework to summarize the practice-based evidence for community-based exercise programs to improve QOL can provide information that goes beyond "did the program work," to enhance the generalizability and scalability of programs for cancer survivors.

The purpose of this study was to conduct a scoping review of published, peer-reviewed studies evaluating community-based exercise programs for cancer survivors. Due to RE-AIM's broad focus and emphasis on generalizability, a scoping methodology was chosen to identify gaps in current literature in practice-based evidence. This review sought to address the following research question: "What is known about the reach, effectiveness, adoption, implementation, and maintenance of community-based exercise programs for adult cancer survivors that will help inform generalizability and scalability?"

Methods

Scoping review methods are appropriate for answering broad research questions and to gain an appreciation of the nature of existing evidence [16]. Scoping review methodology may be used to identify gaps in knowledge or direct the development of focused research questions [16], in contrast to a systematic review which is designed to provide a quantitative synthesis or evaluation of study quality. This study included the following key phases of the scoping review framework: (1) identifying the research question; (2) identifying relevant studies; (3) refining the selection; (4) charting (i.e., coding) the data; and (5) collating, summarizing, and reporting the results [17, 18].

Identifying relevant studies

A systematic literature search was conducted to identify studies that reported the results of community-based exercise programs for cancer survivors. The search strategy was established by the authors (KC, MH, and HL) and reviewed by a librarian trained in systematic searches. PubMed, Web of Science, and EBSCO databases were searched for publications between 1980 and March 2018 using the keywords: cancer or neoplasms, exercise, physical activity, rehabilitation/therapy, community, and community health services. For example, in the Web of Science database, the following search strategy was used: "community* (topic) AND cancer (title) AND exercise OR physical activity (title) AND rehabilitation OR therapy (topic). A similar search strategy was used in the remaining databases. Additional studies were identified by examining the reference lists of included studies.

Study selection

Duplicates were removed, and then two reviewers (KC and MH) screened titles and abstracts. Inclusion criteria were applied to the remaining full-text publications for final study selection. To be included, studies had to meet all of the following criteria: (1) target population of adult (≥ 18 years) cancer survivors; (2) with at least one face-to-face exercise session (i.e., not home-based or telehealth); (3) identified as a community-based program, defined as explicit use of the word "community," and/or utilizing a community-based setting (e.g., fitness center and gathering location), and/or evaluation of a program (delivered in a community, academic, or clinical setting) with the primary aim of providing a health-promoting exercise program to cancer survivors; (4) quasi-experimental (i.e., non-randomized), pre-post, or randomized design; and (5) measured QOL at pre- and post-program. During the search, complementary publications (i.e., publication reporting different elements of the same program) were identified. In these situations, the publication of the primary outcomes of (QOL) was included in the review, and the

complementary paper(s) were referenced if specific information (e.g., maintenance, implementation) was reported separately. Screening results were compared by the two independent reviewers; discrepancies or uncertainties were resolved by consulting the full-text or a third reviewer (HL) when necessary to reach consensus.

Data extraction and charting

To establish inter-rater reliability, KC and MH randomly selected five full-text publications to chart independently, then all authors met to review the initial charting and establish consensus. The objectives of data extraction were to describe (1) *r*each, (2) *e*fficacy/effectiveness of the program for improving QOL, (3) *a*doption, (4) *i*mplementation, and (5) *m*aintenance. Full-text articles included in the review were abstracted for data to describe the RE-AIM dimensions using the questions outlined in Table 1. KC and MH independently abstracted and charted the data from each article into a Microsoft Excel spreadsheet; final inter-rater reliability was 100%.

Collating and summarizing results

Data were entered into a Microsoft Excel spreadsheet independently by two reviewers (KC and MH). Abstracted data were compared between co-authors, and any discrepancies were resolved via discussion, and involvement of a third reviewer (HL). The data were collated using frequencies, means and standard deviations, *p* values, and effect size (Cohen's *d*) as appropriate. When not provided, the effect size was calculated for overall QOL in studies that reported means and standard deviations.

Results

The database search identified 553 potentially eligible articles. See Fig. 1 for the number and reasons for exclusion through the screening process. A total of 31 articles met all inclusion criteria, represented unique community-based exercise programs for cancer survivors, and were included for data abstraction.

Program characteristics

Articles were published in 2003–2017. Study designs included pre-post cohort ($n = 28$, 90.3%) with two [19–41] or more [42–46] time points of measures and RCT with an active or waitlist control group ($n = 3$, 9.7%) [47–49]. Means and/or frequencies of participant and program characteristics are summarized in Table 2. See Table 3 for a detailed summary of each program.

Reach

Five (16.1%) studies reported the representativeness of program participants in reference to a larger population [30, 31, 40, 43, 44]. Six (19.4%) programs included only women diagnosed with breast cancer [21–23, 31, 33, 35], and the remaining programs ($n = 25$, 80.6%) included other cancer types. Less than half of the reviewed studies reported race/ethnicity ($n = 14$, 45.2%), and the majority of participants were non-Hispanic white ($M = 76.5 \pm 25.2\%$, range = 0–100%) [19, 21, 23, 25, 29, 30, 35–37, 42–44, 46, 47]. One program included African American participants, exclusively [35]. Eleven programs (35.5%) reported level of education [19, 21, 23, 30, 31, 35, 36, 42, 43, 46, 47], and of those, 72.7% had an average education level of an associate's degree or greater.

Fourteen programs (45.2%) reported reasons for non-enrollment (irrespective of eligibility criteria) [20–24, 26–28, 30, 35, 42, 44, 46, 47]. Common reasons were lack of interest, inability to attend due to work or other time constraints, and inability to commute. Reasons for withdrawal from the program were reported by $n = 15$ (48.4%) studies [20, 22, 23, 26–28, 31–34, 39, 43–46], and most commonly included scheduling/time conflicts due to work, family, travel, or cancer treatment ($n = 10$, 33.7%); medical complications or cancer progression/reoccurrence ($n = 14$, 93.3%); and treatment-related side effects ($n = 11$, 73.3%). The average program completion rate was $M = 75.3 \pm 18.1\%$ (range = 25.2–100%, $n = 31$), defined as either completion of post-program assessment or sufficient attendance. Twelve studies (38.7%) assessed differences between completers versus non-completers [24, 27, 29–31, 34, 36, 39, 43, 44, 46, 47]. Of those, most ($n = 7$, 58.3%) found a significant difference in at least one participant characteristic (e.g., age, sex, stage of diagnosis, and employment status) [34, 36, 39, 43, 44, 46, 47].

Efficacy/effectiveness

Fourteen programs (45.2%) monitored for adverse events, of those, most ($n = 11$, 78.6%) reported no occurrence of adverse events [22, 26, 31, 32, 34, 37, 40, 43, 46–48]. Of the studies that did report adverse events ($n = 3$, 9.7%), the number of events ranged from 2 to 11. Adverse events included falls, exacerbation of existing lymphedema, chronic vertigo, bursitis, and a Baker's cyst. One study reported a fall related to loss of balance [20], two reported exacerbation or flare-up of lymphedema [35, 36], and one reported exacerbation of chronic vertigo, a flare-up of bursitis, and a Baker's cyst [36].

Several different measures of QOL were used. The most common was the FACT-system questionnaires

Table 1 RE-AIM dimensions and questions for abstraction

RE-AIM dimension	Defined as	Research questions
Reach	Participation rate within target population, characteristics, and representativeness of participants	• What was the target sample population? • Were participants with cancer types other than breast included? • What was the socioeconomic and race/ethnic make-up of the sample? • Did the study report representativeness of participants, and if so, compared to what target population (e.g., county and hospital system)? • Did the study report reason for withdrawal/attrition, and if so, did they examine participant characteristics between those who completed the program versus those who did not?
Effectiveness	Ability of the program to result in improvements in quality of life (QOL)	• Were adverse events reported? If so, what were they? • How was QOL measured? • Was the improvement in QOL statistically significant (from pre to post intervention, or compared to a control group, if applicable)? • Was effect size or clinical significance reported for QOL? • What was the range of effect size for pre- to post-program changes in QOL?
Adoption	System-level uptake of given program	• Was adoption of the program at more than one site/setting reported? • If so, how many sites participated out of the number than were available/approached? • What was the location or setting of the program? • Who conducted/delivered the program? • What were the required credentials and training for program staff?
Implementation	Factors of program delivery, including delivery agent, setting, cost, and consistency of delivery	• What was the duration of the program? • What was the frequency and duration of face-to-face supervised exercise? • Were there elements other than supervised exercise included in the program (e.g., education, counseling, home-based exercise prescription, and participant materials)? • Were programs based on established exercise recommendations or guidelines for cancer survivors? • Was fidelity assessed (either within or between sites)? • What were the operating costs associated with the program? • How much did participants have to pay for the program? • How were programs funded?
Maintenance	System-level sustainability and long-term evaluation of individual-level outcomes	• Were individual-level outcomes assessed after completion of the program (i.e., final active intervention visit)? • If yes, what was the time interval from the end of the program to the follow-up or maintenance interval? • How did the study define "successful maintenance" of program effects? • Were the effects of the program on the primary outcome "maintained" (as determined by study definition)? • Was the program sustained longer than the duration of the study? • If yes, for how long? • Were plans or strategies for maintenance stated/described/discussed?

(i.e., general and tumor-specific forms) ($n = 13$, 41.9%) (www.facit.org), the Medical Outcomes Survey (MOS) 36-item short-form survey instrument (SF-36) ($n = 8$, 25.8%) (https://www.rand.org/health-care/surveys_tools/mos/36-item-short-form.html), and the European Organization for Research or Treatment of Cancer (EORTC) Quality of Life Questionnaire (QLQ) ($n = 4$, 12.9%) (https://www.eortc.org/research_field/quality-of-life). Other measures of QOL used for each program are displayed in Table 3.

Twenty-five (80.6%) programs reported an improvement in at least one subscale, or total QOL from pre- to post-program ($p < 0.05$). Effect size (Cohen's d) for changes in overall QOL (i.e., total or composite score) from pre- to post-program was either reported by the study or calculated by the research team (KC and MH) when possible ($n = 21$ studies, 67.7%). The average effect size was $d = 0.45 \pm 0.30$ (range = − 0.7–1.18). Nine programs (29.0%) achieved moderate to large effect sizes ($d \geq 0.50$) for at least one domain or subscale of QOL. Only six $n = 6$, (19.4%) studies reported minimal, clinically important difference (i.e., MCID) for changes in QOL. Of those, the MCID was achieved for total well-being on the FACT-G ($n = 3$, 50.0%) [22, 29, 35], the well-being subscale on the ESAS ($n = 1$, 17.0%) [20], and the physical and emotional subscales of the SF-36 ($n = 1$, 17.0%) [30].

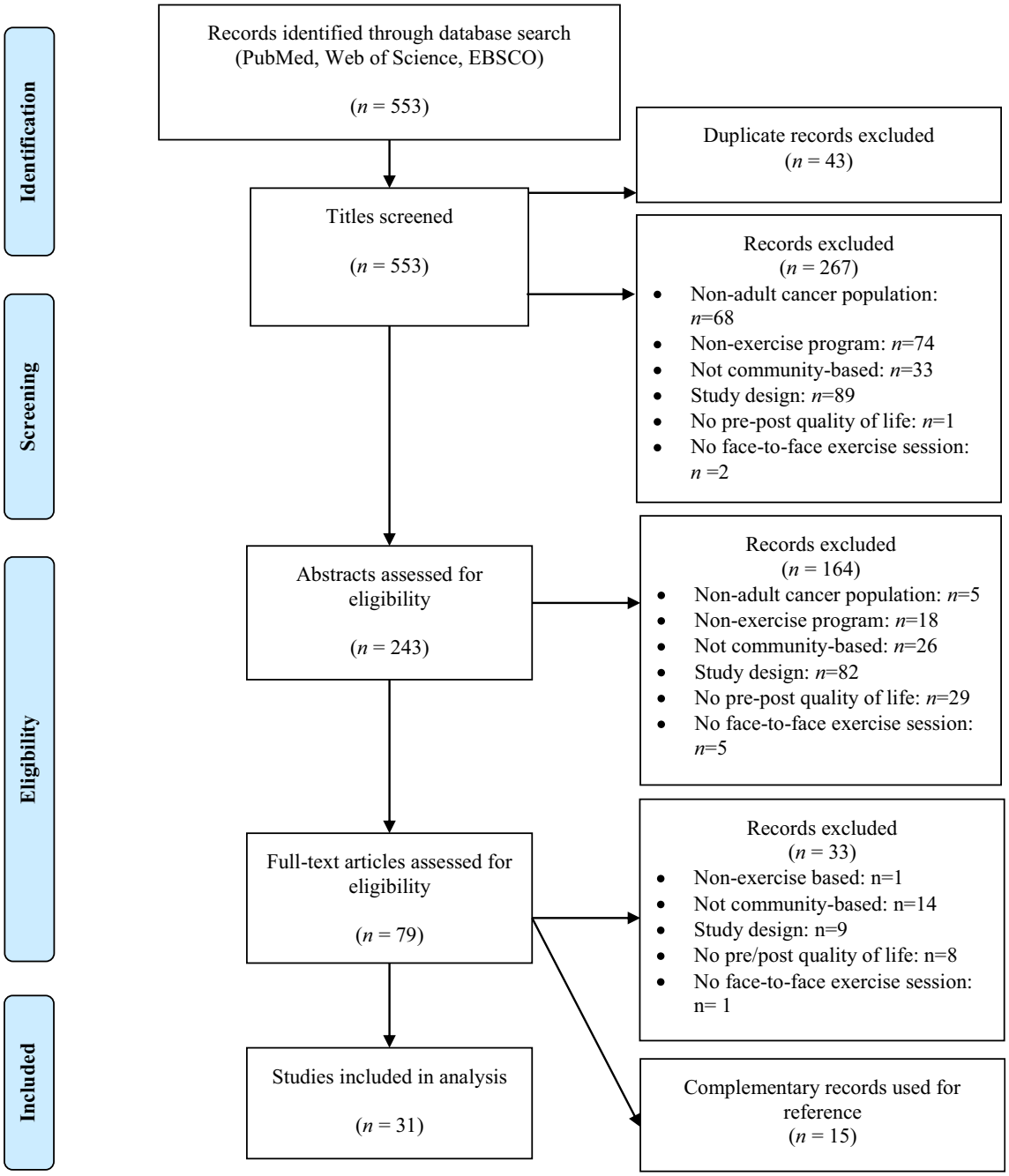

Fig. 1 PRISMA flow diagram

Adoption

Twenty-seven studies (87.1%) reported the number of participating or "host" sites for the program ($M = 2.44 \pm 3.4$, median = 1, range = 1–14). Host sites included community fitness or wellness centers ($n = 8$, 25.8%) [19, 20, 23, 31, 34, 37, 44, 45], YMCAs ($n = 6$, 19.4%) [21, 22, 26, 28, 36, 47], outpatient clinics ($n = 6$ 19.4%) [29, 32, 38–40, 46], a cancer center or hospital ($n = 4$, 12.9%) [24, 27, 41, 49], or non-disclosed community locations ($n = 6$, 19.4%) [25, 30, 33, 35, 42, 48] including outdoor facilities (i.e., track, river, open water, and an uphill road; $n = 3$, 9.7%) [25, 33, 48]. One program utilized multiple community locations donated in-kind (i.e., churches, community, and cancer centers) [43, 52].

Implementation

Exercise sessions were primarily implemented by an exercise professional (e.g., personal trainer, exercise physiologist/kinesiologist) ($n = 16$, 51.6%); [20, 21, 23, 24, 27, 30–32, 34, 35, 38, 40, 46–49], or by multiple individuals with a variety of training (e.g., exercise trainer, coach, nurse, physical therapist, etc.; $n =$

Table 2 Program and participant characteristics ($N = 31$)

	M ± SD (range)
Sample size	123.97 ± 154.34 (12–701)
Age	57.84 ± 5.63 (48.00–70.40)
Treatment status	
% Current active treatment ($n = 20$)*	28.08 ± 24.68 (0–100)
% Current hormone treatment ($n = 9$)*	52.89 ± 23.46 (21.5–100)
Months since active treatment completion ($n = 10$)*	32.97 ± 26.51 (4.96–84.00)
Program duration (weeks)	12.60 ± 5.59 (3–30)
Exercise sessions attended (%)	74.64 ± 20.09 (25.3–100)
Outcomes measured	*N* (%) of studies
Physical activity	7 (22.6)
Objective physical function	26 (83.9)
Fatigue	24 (77.4)
Depression/anxiety/distress	14 (45.2)
Other symptoms	32 (74.2)
Participant satisfaction	11 (35.5)

*Sample size represents those that reported given characteristic

14, 45.2%); [22, 25, 26, 28, 29, 33, 36, 37, 39, 41–45]. One study did not describe delivery personnel [19]. Many ($n = 29$, 93.5%) programs required delivery personnel to have educational qualifications, including a bachelor's degree in exercise science, nursing, physical therapy or equivalent ($n = 15$, 48.4%), personal training certification ($n = 3$, 9.7%), exercise physiologist certification ($n = 7$, 22.6%), or another discipline-specific certification (i.e., nursing, coaching, lymphedema therapist) ($n = 6$, 19.4%). About half of programs ($n = 16$, 51.6%) required instructors to have cancer-specific credentials, such as a LIVESTRONG foundation trainer certification ($n = 4$, 12.9%) [22, 26, 28, 47], American College of Sports Medicine (ACSM)/American Cancer Society-Cancer Exercise Specialist certification (https://www.acsm.org/get-stay-certified/get-certified/specialization/cet; $n = 3$, 18.8%) [29, 30, 35], Rocky Mountain Cancer Exercise Specialist certification (https://www.unco.edu/nhs/cancer-rehabilitation-institute/education/workshop/; $n = 3$, 9.7%) [29, 38, 39], or an oncology nursing certification ($n = 1$, 3.4%) [32].

Program duration was $M = 12.60 \pm 5.59$ (range = 3–30) weeks. One program had an unlimited duration so that participants could discontinue and rejoin at any time [43]. Face-to-face exercise sessions were offered once ($n = 3$, 9.7%), twice ($n = 17$, 54.8%), or three times per week ($n = 5$, 16.1%). Most program's exercise sessions lasted 60 ($n = 11$, 35.5%) or 90 ($n = 7$, 22.6%) minutes. Many ($n = 12$, 38.7%) included an additional form of exercise support as participant incentives, ranging from free gym memberships to the provision of home-based exercise prescription and equipment (i.e., resistance bands, fitness balls, and bathing suit) [20, 21, 24, 31, 33, 36, 37, 43–47]. Thirteen programs (41.9%) included at least one education and/or discussion session component, and many held reoccurring sessions on a weekly [29, 36, 37, 45], bi-weekly [31], or twice-monthly basis [26].

Santa Mina et al. and Noble et al. were the only studies to report attention to implementation fidelity [34, 44]; including the creation of a program manual to guide implementation, and regular meetings between program personnel and research investigators. However, neither study reported fidelity to program implementation across multiple waves/cohorts or sites.

None of the reviewed studies reported operating costs of the program. Sixteen studies (51.6%) reported the cost of the program for participants (i.e., program fee). Of these, most were free of charge to participants ($n = 11$, 68.8%) [22–24, 28, 31, 35, 36, 42–45], others were fee-for-service (i.e., individual charge for each session and assessment; range = $15–$100; $n = 1$, 6.3%) [30], had an upfront program fee ($n = 2$, 12.5%) [26, 29], or were subsidized by insurance ($n = 2$, 12.5%) [39, 40]. Many programs received funding from grants or donations from non-profit organizations ($n = 9$, 29.0%), an affiliated hospital system ($n = 2$, 6.5%) [21, 45], internal resources ($n = 1$, 3.2%) [48], or from multiple funders ($n = 7$, 22.6%) [25, 26, 30, 35, 37, 43, 47]. Three programs (9.7%) received no funding [22, 34, 41]. Nine programs (34.5%) did not report funding information [19, 24, 27–29, 32, 38, 42, 46].

Maintenance

Five studies measured individual-level maintenance of QOL (16.1%). Four of the five studies (80%) that included a follow-up assessment of QOL found no statistically significant decline in QOL from post-program to follow-up [31, 39, 42, 44]. The average duration of follow-up from the end of the program was $M = 4.33 \pm 2.07$ (range = 1–6) months. None of the studies reviewed provided an ad hoc definition of "successful maintenance" for individual-level outcomes.

In terms of setting-level maintenance, many ($n = 9$, 29%) programs were ongoing, either as reported in the study or identified via an active program website (program name entered into Google, October 2018) [26, 27, 31, 34, 36, 38, 43–45]. At the time of publication, programs that were ongoing had been operating for $M = 5.5 \pm 1.5$ (range = 4–9) years. Twenty-five studies (80.6%) discussed strategies for program maintenance ($n = 25$), and common themes were obtaining stakeholder (i.e., investors, oncology practitioners, and community members) buy-in ($n = 10$; 32.3%) [31, 33–36, 39, 40, 43, 45, 48], and affiliation with existing program or organization (i.e., cardiac rehabilitation, support groups, YMCA, Livestrong, and community hospital) ($n = 19$, 61.3%) [20–22, 24, 26–28, 35, 36, 39–48].

Discussion

The purpose of this scoping review was to summarize what is known about the reach, effectiveness (for improving QOL),

Table 3 Summary of all programs ($N = 31$)

Citation	Program name and setting	Participants	Delivery	Components	Quality of life[a]	System-level maintenance status
Andersen (2012) [24]	Name: not stated Setting: Herley University Hospital ($n = 1$); DEN	Diagnosis: lung Sample size: 51 Treatment status: all	Fee: no cost to participants Program duration: 2 weeks Frequency: 2x/week Agent: not reported	Activity type: aerobic, flexibility, relaxation, respiratory techniques Education: yes Format: group	Measure: EORTC QLQ-30 & QLQ-LC13 Pre-post Δ in QOL: $p > 0.05$, $d = 0.30$	Unknown
Browning (2017) [42]	Name: not stated Setting: Metropolitan area locations ($n = 3$); USA	Diagnosis: all types (52% breast) Sample size: 33 Treatment status: all	Fee: no cost to participants Program duration: 10 weeks Frequency: 1–2×/week Agent: mind-body certified instructors (i.e., yoga, Tai Chi, Qigong)	Activity type: Yoga, Tai Chi, Qigong Education: no Format: group	Measure: FACT-G Pre-post Δ in QOL: statistical significance not reported, $d = 0.49$	Unknown
Capozzi (2015 & 2016) [20, 50]	Name: *ENHANCE* Setting: Holy Cross Wellness Center ($n = 1$); CAN	Diagnosis: brain, head, and neck Sample size: 21 Treatment status: all	Fee: unknown Program duration: 12 weeks Frequency: 1×/week Agent: certified exercise physiologist	Activity type: aerobic, resistance, balance, flexibility Education: yes Format: group	Measure: ESAS: well-being subscale Pre-post Δ in QOL: $p > 0.05$, mean Δ achieved MCID, $d = .73$	Unknown
Carter (2012) [25]	Name: not stated Setting: local Walking paths and river; SC, USA	Diagnosis: all types (paddling = 49% breast, walking = 63% breast) Sample size: 133 Treatment status: all	Fee: unknown Program duration: 8 weeks Frequency: 2×/week Agent: "experienced coaches and program staff"	Activity type: aerobic and resistance (*only paddling*) Education: no Format: group	Measure: FACT-G, MOS SF-36 Pre-post Δ in QOL: overall QOL not reported	Unknown
Cheifetz (2014) [26]	Name: *CanWell* Setting: YMCA ($n = 1$); CAN	Diagnosis: all types (52% breast) Sample size: 115 Treatment status: all	Fee: YMCA membership; scholarships available Program duration: 12 weeks Frequency: 2×/week Agent: YMCA instructors with cancer training	Activity type: aerobic, resistance, flexibility Education: yes Format: group	Measure: FACT-G Pre-post Δ in QOL: $p < 0.01$, $d = 0.33$	Ongoing since 2009
Christopher (2004) [19]	Name: *Get fit—stay fit* Setting: community agency ($n = 1$); USA	Diagnosis: all types (91% breast) Sample size: 23 Treatment status: all	Fee: not reported Program duration: 12 weeks Frequency: 2×/week Agent: not reported	Activity type: aerobic Education: no Format: group	Measure: QOL-CS Pre-post Δ in QOL: statistical significance not reported, unable to calculate effect size	Ongoing at publication, 5 years
De Backer (2007) [27]	Name: not stated Setting: community hospital ($n = 1$); NL	Diagnosis: all types (60% breast) Sample size: 68 Treatment status: ≥ 6 weeks post-chemotherapy completion	Fee: unknown Program duration: 18 weeks Frequency: 1–2×/week Agent: physiotherapist	Activity type: aerobic and resistance Education: no Format: group	Measure: EORTC QLQ-C30 Pre-post Δ in QOL: $p < 0.01$, $d = 0.82$	Ongoing at publication, 5 years
DeJesus (2017) [21]	Name: not stated Setting: YMCA ($n = 1$); CAN	Diagnosis: breast Sample size: 20 Treatment status: ≤ 4 months post-treatment completion	Fee: not reported Program duration: 16 weeks Frequency: 3×/week Agent: cardiac rehab kinesiologist	Activity type: aerobic Education: no Format: individually supervised	Measure: FACT-Breast Pre-post Δ in QOL: $p = 0.02$, $d = 0.27$	Unknown

Table 3 (continued)

Citation	Program name and setting	Participants	Delivery	Components	Quality of life[a]	System-level maintenance status
Foley (2015) [28]	Name: *LIVESTRONG* Setting: YMCAs ($n = 6$); GA, USA	Diagnosis: all types (75% breast) Sample size: 76 Treatment status: all	Fee: no cost to participants Program duration: 12 weeks Frequency: 2×/week Agent: certified LIVETRONG instructors	Activity type: aerobic, resistance, balance, flexibility Education: no Format: group	Measure: FACT-G Pre-post Δ in QOL: $p < 0.001$, $d = 0.56$	Ongoing via LIVESTRONG
Foley (2016 & 2017) [22, 51]	Name: *LIVESTRONG* Setting: YMCAs ($n = 6$); GA, USA	Diagnosis: breast Sample size: 60 Treatment status: post-treatment completion	Fee: no cost to participants Program duration: 12 weeks Frequency: 2×/week Agent: YMCA instructors	Activity type: aerobic, resistance, balance, flexibility Education: no Format: group	Measure: FACT-G Pre-post Δ in QOL: $p = 0.001$, $d = 0.66$, mean Δ achieved MCID	Ongoing via LIVESTRONG
Haas (2011 & 2012) [43, 52]	Name: *FitSTEPS for Life* Setting: various community locations ($n = 14$); TX, USA	Diagnosis: all types (50% breast) Sample size: 701 Treatment status: all	Fee: no cost to participants Program duration: unlimited Frequency: drop-in (2–3×/week) Agent: "staff and volunteers"	Activity type: aerobic, resistance, flexibility Education: no Format: group (drop-in)	Measure: MOS SF-36 Pre-post Δ in QOL: $p < 0.01$, unable to calculate effect size	Ongoing since 2003
Irwin (2017) [47]	Name: *LIVESTRONG* Setting: YMCAs (n = unknown), USA	Diagnosis: all types (52% breast) Sample size: 95 Treatment status: all	Fee: unknown Program duration: 12 weeks Frequency: 2×/week Agent: certified LIVETRONG instructors	Activity type: aerobic, resistance Education: no Format: group	Measure: FACT-G Pre-post Δ in QOL: $p = 0.04$, unable to calculate effect size	Ongoing via LIVESTRONG
Kirkham (2016 *a*) [29]	Name: *Strides to Strength Cancer Rehabilitation Program* Setting: outpatient cancer rehabilitation facility ($n = 1$); USA	Diagnosis: all types (61% breast) Sample size: 299 Treatment status: all	Fee: $300, scholarships available Program duration: 12 weeks Frequency: 2×/week Agent: certified cancer exercise trainer/specialist, registered dietician, and nurse	Activity type: aerobic, resistance, flexibility, and relaxation Education: yes Format: group	Measure: FACT-G Pre-post Δ in QOL: $p < 0.001$, $d = 0.42$, 60% achieved MCID	Unknown
Kirkham (2016 *b*) [30]	Name: not stated Setting: community location ($n = 2$); CAN	Diagnosis: all types (58% breast) Sample size: 48 Treatment status: all	Fee: $85–$100/assessment, $15–$75/session Program duration: 12–16 weeks Frequency: drop-in (2–3×/week) Agent: certified cancer exercise trainer/specialist	Activity type: aerobic, resistance, flexibility Education: no Format: individually supervised or group option	Measure: MOS SF-36 Pre-post Δ in QOL *(physical)*: $p = 0.02$, $d = 0.46$, mean Δ achieved MCID	Unknown
Knobf (2014) [23]	Name: not stated Setting: community fitness centers ($n = 3$)	Diagnosis: breast Sample size: 31 Treatment status: ≤36 months post-treatment	Fee: no cost to participants Program duration: 16–24 Frequency: drop-in (2–3×/week) Agent: exercise physiologist	Activity type: aerobic, resistance, flexibility Education: no Format: group (drop-in)	Measure: MOS SF-36 Pre-post Δ in QOL *(mental)*: $p = 0.002$, $d = 0.58$	Unknown
Leach (2014, 2015, 2016) [31, 53, 54]	Name: *BEAUTY* Setting: the Thrive Centre University of Calgary ($n = 1$); CAN	Diagnosis: breast Sample size: 96 Treatment status: active or ≤3 months post-treatment	Fee: no cost to participants Program duration: 12–24 weeks Frequency: 1–2×/week Agent: certified exercise physiologist with breast cancer training	Activity type: aerobic, resistance, flexibility Education: yes Format: group and home-based	Measure: FACT Breast and FACT-G Pre-post Δ in QOL: $= p > 0.05$, $d = -0.03$	Ongoing since August 2011

Table 3 (continued)

Citation	Program name and setting	Participants	Delivery	Components	Quality of life[a]	System-level maintenance status
Losito (2006) [32]	Name: not stated Setting: local community hospital-outpatient physical therapy gym ($n = 1$); USA	Diagnosis: all types (57% breast) Sample size: 12 Treatment status: all	Fee: unknown Program duration: 6 weeks Frequency: 2/week Agent: oncology certified nurse	Activity type: aerobic, resistance, flexibility Education: no Format: group	Measure: MOS SF-36 Pre-post Δ in QOL: statistical significance not reported, unable to calculate effect size.	Unknown
Ng (2017) [33]	Name: not stated Setting: community roads, pool, and open water (n = unknown); WI, USA	Diagnosis: breast Sample size: 25 Treatment status: ≥ 3 weeks post-treatment	Fee: unknown Program duration: 14 weeks Frequency: 2×/week Agent: triathlon coach, supervised by member of medical team	Activity type: aerobic, core exercises Education: yes Format: group	Measure: FACT-breast and FACT-G Pre-post Δ in QOL: $p < 0.01$, mean Δ achieved MCID, unable to calculate effect size	Unknown
Noble (2011) [34]	Name: *UW WELL-FIT* Setting: Manulife Wellness Center-University of Waterloo ($n = 1$); CAN	Diagnosis: all types (59% breast) Sample size: 557 Treatment status: active	Fee: unknown Program duration: 12–16 weeks Frequency: 2×/week Agent: certified exercise physiologist	Activity type: aerobic, flexibility Education: no Format: individualized group	Measure: MOS SF-36 Pre-post Δ in QOL: $p < 0.001$, $d = 0.58$	Ongoing since 2002
Nock, (2014, 2015) [35, 62]	Name: not stated Setting: community-based cancer support center ($n = 1$); USA	Diagnosis: breast Sample size: 19 Treatment status: ≤ 12 months post-treatment	Fee: no cost to participants Program duration: 20 weeks Frequency: 2×/week Agent: certified cancer exercise trainer	Activity type: resistance Education: yes Format: group	Measure: FACT-G and FACT-B Pre-post Δ in QOL: $p = 0.05$, mean Δ achieved MCID, $d = 0.34$	Unknown
Rajotte (2012) [36]	Name: *Exercise and Thrive* Setting: YMCA ($n = 13$); WA, USA	Diagnosis: all types (56% breast) Sample size: 224 Treatment status: ≥ 90 days post-treatment	Fee: no cost to participants Program duration: 12 weeks Frequency: 2×/week Agent: YMCA PT's with ≥ 1-year experience and cancer-specific training (16-h)	Activity type: aerobic, resistance Education: yes Format: group	Measure: MOS SF-36 Pre-post Δ in QOL: $p < 0.001$, $d = 0.35$	Ongoing via LIVESTRONG
Reynolds (2015) [37]	Name: *Fit and strong!* Setting: local health center ($n = 1$); TX, USA	Diagnosis: all types (52% breast) Sample size: 72 Treatment status: completed	Fee: unknown Program duration: 8 weeks Frequency: 3×/week Agent: completed fit and strong! master training program, chronic disease self-management certification (Stanford CDSMP)	Activity type: aerobic, resistance Education: yes Format: group	Measure: QLACS Pre-post Δ in QOL: $p > 0.05$, $d = -0.20$	Unknown
Santa Mina (2017) [44]	Name: *The Wellspring Cancer Exercise Program* Setting: wellspring community facilities ($n = 4$); ON, CAN	Diagnosis: all types (56% breast) Sample size: 224 Treatment status: all	Fee: no cost to participants Program duration: 30 weeks Frequency: 1–2×/week Agent: physiotherapist, exercise physiologist, or kinesiologist with cancer smart rehabilitation and exercise techniques training	Activity type: aerobic, resistance, flexibility, balance Education: no Format: group	Measure: FACT-G Pre-post Δ in QOL: $p < 0.05$, $d = 1.06$	Ongoing since ≤ 2012
Schmitt (2016) [48]	Name: not stated		Fee: unknown	Activity type: aerobic	Measure: EORTC	Unknown

Table 3 (continued)

Citation	Program name and setting	Participants	Delivery	Components	Quality of life[a]	System-level maintenance status
	Setting: community outdoor locations (n = unknown); GER	Diagnosis: all types (2 groups: high intensity = 85% breast low/moderate intensity = 77% breast) Sample size: 26 Treatment status: completed	Program duration: 3 weeks Frequency: 2–3×/week Agent: "therapist"	Education: yes Format: group	QLQ-C30 Pre-post Δ in QOL: $p < 0.05$; $d = 0.79$ (high intensity), $d = 1.14$ (low/moderate intensity)	
Schneider (2007) [38]	Name: *University of Northern Colorado (UNC) cancer rehabilitation program* Setting: UNC (formerly Rocky Mountain) Cancer Rehabilitation Institute ($n = 1$); CO, USA	Diagnosis: breast (84%) and prostate (16%) Sample size: 135 Treatment status: all	Fee: unknown Program duration: 24 weeks Frequency: 2 or 3×/week Agent: certified cancer exercise specialists	Activity type: aerobic, resistance, flexibility Education: no Format: individually supervised	Measure: FPQLIC Pre-post Δ in QOL: during-treatment: $p = 0.04$, $d = 1.21$ Post-treatment: $p = 0.03$, $d = 0.35$	Ongoing since 1996
Segal (2003) [49]	Name: not stated Setting: cancer fitness centers ($n = 2$); CAN	Diagnosis: prostate Sample size: 82 Treatment status: receiving ADT for ≥ 3 months after recruitment	Fee: unknown Program duration: 12 weeks Frequency: drop-in (2–3×/week) Agent: "certified fitness consultant"	Activity type: resistance Education: no Format: individualized group	Measure: FACT-P Pre-post Δ in QOL: $p < 0.001$, $d = 0.12$	Unknown
Skinner (2016) [40]	Name: not stated Setting: exercise clinic ($n = 1$); AUS	Diagnosis: prostate Sample size: 51 Treatment status: completed	Fee: no cost to participants (government subsidized-Medicare) Program duration: 4 weeks Frequency: 1×/week Agent: accredited exercise physiologists	Activity type: resistance, flexibility, balance Education: yes Format: individually supervised	Measure: EORTC QLQ-PR25, SWEMWBS Pre-post Δ in QOL: $p = 0.04$ (SWEMWBS), unable to calculate effect size	Unknown
Smith (2016) [41]	Name: not stated Setting: hospital ($n = 1$); OH, USA	Diagnosis: all types (70% breast) Sample size: 20 Treatment status: all	Fee: unknown Program duration: 6–10 weeks Frequency: 1–2×/week Agent: cardiovascular nurse and exercise physiologist	Activity type: aerobic, resistance, flexibility Education: no Format: individualized group	Measure: COOP Pre-post Δ in QOL: $p < 0.01$, $d = 1.18$	Unknown
Swenson (2014) [39]	Name: *cancer rehabilitation strengthening and conditioning program* Setting: Nicolette Park Heart and Vascular Fitness Center ($n = 1$); MN, USA	Diagnosis: all types (26% breast) Sample size: 115 Treatment status: all	Fee: no cost to participants (subsidized by insurance) Program duration: 8 weeks Frequency: unknown Agent: physical therapist trained at Rocky Mountain Cancer Institute	Activity type: aerobic, resistance Education: no Format: individually supervised or group	Measure: MOS SF-36 Pre-post Δ in QOL: $p < 0.005$, unable to calculate effect size	Unknown
Van Gerpen (2013) [45]	Name: *LifeSpring*	Diagnosis: all types (63% breast) Sample size: 182	Fee: no cost to participants Program duration: 12 weeks Frequency: 2×/week	Activity type: aerobic, resistance, flexibility, relaxation, yoga, Pilates,	Measure: 0–10 Likert scale	Ongoing since 2007

Table 3 (continued)

Citation	Program name and setting	Participants	Delivery	Components	Quality of life[a]	System-level maintenance status
	Setting: University of Nebraska medical center's wellness center ($n = 1$); NE, USA	Treatment status: all	Agent: physical therapist or exercise physiologist with cancer experience	BODYFLOW, aquatic exercise Education: yes Format: group	Pre-post Δ in QOL: $p < 0.0001$, $d = 0.75$	
Young-McCaughan (2003) [46]	Name: not stated Setting: cardio-pulmonary rehabilitation clinic ($n = 1$); USA	Diagnosis: all types (22% breast) Sample size: 62 Treatment status: all	Fee: unknown Program duration: 12 weeks Frequency: 2×/week Agent: exercise physiologist	Activity type: aerobic, resistance Education: yes Format: individualized group	Measure: CARES-SF Pre-post Δ in QOL: $p = 0.03$, $d = 0.27$	Unknown

[a] Only results for overall quality of life or well-being are reported

Unknown, did not report; *QOL*, quality of life; *FACT-G*, functional assessment of cancer therapy-general [63]; *QOL-CS*, quality of life-cancer survivors scale [64]; *MOS SF-36*, medical outcomes survey short form [65]; *ESAS*, Edmonton symptom assessment scale [66]; *EORTC QLQ*, European Organization of Cancer Core Quality of Life Questionnaire [67]; *QLQ-LC13*, lung cancer-specific questionnaire (from EORTC)[67]; *QLACS*, the quality of life in adult cancer survivors survey [68]; *ADT*, androgen deprivation therapy; *EORTC QLQ-PR25*, European Organization of Cancer Core Quality of Life Questionnaire Prostate Specific Module [69]; *SWEMWBS*, The Short Warwick-Edinburgh Mental Well-being Scale[70]; *COOP*, Dartmouth Cooperative Functional Assessment Charts [71]; *CARES-SF*, The Cancer Rehabilitation Evaluation System-short form [72]; *FPQLIC*, The Ferrans and Powers Quality of Life Index Cancer Version III [73]

adoption, implementation, and individual- and system-level maintenance of community-based exercise programs for adult cancer survivors.

Reach

In terms of reach, few studies compared representativeness of their sample to a larger population. Study samples tended to have a higher prevalence of individuals who had been diagnosed with breast cancer [30, 44], who were more physically active [31, 40], and of higher socioeconomic status [31], than the reference population. Reach was also evaluated by comparing the characteristics of participants versus non-participants, program completers versus non-completers, and reasons for not enrolling in the program. One program found that patients who were younger, who were single parents, and of lower socioeconomic status were less likely to participate [43]. In general, participants who did not complete programs were younger [36, 43, 46], working [43], female [43], and of non-Caucasian race [47] and had been recently diagnosed [36], had lung or advanced cancer [34, 36, 43], or were receiving active treatment [39, 46]. A common reason for non-enrollment was ineligibility due to strict eligibility criteria (i.e., health/physical status, informed consent or physician clearance; $n = 9$, 29.0%) [20–22, 26–28, 30, 35, 44]. Commonalities between those who did not enroll, and those who did not complete programs indicates an uncertainty of the ideal timing of (i.e., during vs. following treatment) and effects of community-based exercise programs for underserved, hard-to-reach cancer survivors such as minorities, low income, and those of working age or with young families. These groups often have worse cancer-related health and wellness outcomes, and poorer quality of life [55–57].

Improving the reach and representativeness of cancer survivors who enroll and complete community-based exercise programs can help increase the generalizability of these programs. To improve reach and representativeness, future exercise programs should focus on ways to target underserved survivors. This could include: strategies such as involvement of health care providers treating those diagnosed with cancers other than breast; bilingual staff; translated and culturally adapted intervention materials; involvement of community leaders; the use of low-cost technology solutions (i.e., social media and fitness tracking apps) to minimize travel to study sites; and potentially expanded eligibility criteria and accessibility (e.g., accommodation for comorbidities, exercise session times outside of working hours).

Effectiveness

Similar to the exercise intervention literature [7], most programs (80.6%) included in this review showed a statistically significant improvement in at least one domain of QOL, but few studies (19.4%) reported whether improvements were clinically meaningful (i.e., the achievement of MCID). Evaluation of clinically relevant outcomes has been recommended to demonstrate the efficacy/effectiveness of community-based exercise programs for cancer survivors to healthcare providers and other potential stakeholders [8]. Furthermore, assessment of QOL varied greatly, with 11 different measures, and a wide range of effect size (− 0.7–1.18). In addition to clinically relevant outcomes, participant satisfaction is the important patient-centered outcome that should be collected by future programs. Few of the reviewed studies collected information regarding participant satisfaction ($n =$ 11, 35.5%); therefore, we have a limited understanding of the core elements and outcomes of community-based programs that are important to participants. Patient satisfaction with health services may be related to self-efficacy for patients with chronic disease, like cancer, therefore patient satisfaction is a critical element in effective interventions that may influence adherence to the intervention, completion of follow-up assessments, and recruitment of other patients [58, 59].

To make strides in the scalability of community-based exercise programs for cancer survivors, the results of this review, in terms of effectiveness, suggests the use of standardized measures of QOL with established MCID values, and consideration of participant satisfaction.

Adoption

The majority of programs were held in a community fitness or wellness facility and were led by an exercise or fitness professional. Few studies described the process of adoption to additional sites (i.e., growth beyond the original site). Of the eight programs (25.8%) that were adopted to multiple sites, no information was available regarding differences between participating and non-participating sites (i.e., location, facility resources, personnel, populations served) or contextual factors that may have influenced adoption. LIVESTRONG at the YMCA and FitSTEPS for Life [52] are the most widely disseminated community-based exercise programs for adults with cancer, and rigorous program evaluations have been published [22, 28, 36, 43, 47]. Factors that seem to have facilitated the widespread adoption of these programs include the following: institutionalized instructor training materials, program and recruitment materials, and often, grant or stakeholder support for program startup [43, 52, 60]. Though LIVESTRONG at the YMCA [22, 28, 36, 47, 60] and FitSTEPS for Life [43, 52] serve as models for widespread program adoption, more information regarding contextual factors that facilitate successful adoption is needed.

Thus, findings from this review suggest that to enhance scalability, new and ongoing community-based exercise programs for cancer survivors should utilize the standardized program and instructor training manuals, keep detailed

records, and/or collect qualitative information to determine what are the contextual factors that may help or hinder widespread program adoption. In addition, low-cost technology solutions (i.e., social media and fitness tracking apps) and expanded use of community locations in rural areas (i.e., churches, schools, businesses) could improve adoption to hard-to-reach areas by increasing reach and minimizing travel to required to participate.

Implementation

Average program length was 12 weeks and included twice-weekly exercise sessions. While the "formula" of face-to-face, supervised exercise that was utilized by the reviewed programs generally resulted in improved QOL, various delivery methods (i.e., duration, staff, and web-based) need to be tested to determine the core components of community-based exercise programs necessary to improve QOL. None of the reviewed studies reported the cost of program delivery, and there was a wide range of program fees for participants (range = $0–$300). Determining the core components needed to deliver effective programs and the associated costs will enhance future cost-effective implementation. Two programs created a manual of procedures and broadly described it as a facilitator to ongoing implementation and system-level maintenance [34, 44]. However, none of the reviewed studies reported the consistency of program delivery (i.e., process fidelity).

To enhance the scalability of community-based exercise programs for cancer survivors, future studies using pragmatic designs are needed to determine the program delivery characteristics (e.g., duration, supervised contact hours, staff qualifications, and location) that will optimize the cost to effectiveness ratio. In addition, guidelines that dictate the necessary qualifications for program staff (i.e., education, certifications, cancer-specific training) in community settings are needed. For example, survivors with comorbidities or substantial functional limitations may require more specialized care, such as from a nurse and occupational or physical therapist. Current programs should seek to systematically record and report implementation characteristics (e.g., a manual of procedures) and collect and disseminate information regarding the cost of program delivery.

Maintenance

Of the reviewed studies, 16.1% assessed individual-level maintenance of QOL. Promisingly, of those that did, most (80%) showed sustained improvements with an average follow-up of approximately 4 months [31, 39, 42, 44]. In terms of system-level maintenance, 32% of reviewed studies reported that systematic processes were in place for ongoing recruitment and implementation, and 80.6% of studies discussed strategies to support program maintenance. These findings are promising in comparison to a 2014 review of maintenance of exercise interventions for cancer survivors [61], which found less than 10% of included studies measured individual-level maintenance and only one reported system-level maintenance. However, the majority of studies included in the review were RCTs, and individual or setting-level maintenance data collection may not have been part of the study design. To enhance the scalability of exercise programs for cancer survivors in a community-based setting, we suggest that system-level maintenance is critical. More information regarding how and what contributes to the full adoption of a program is needed, and current programs are encouraged to collect and report this information.

Strengths and limitations

The use of the RE-AIM framework to report on both internal and external validity characteristics of community-based exercise programs for cancer survivors was a strength of this review. RE-AIM has been used by more than 200 studies to plan, evaluate, and review health promotion and disease management interventions. This study builds on other previous reviews of community-based exercise programs for cancer survivors which did not evaluate effectiveness for improving QOL or factors related to external validity [9–11], included only RCTs [11], or did not utilize a systematic approach [9, 10].

Limitations of this study include restriction to English language, publications dated 1980 to March 2018, and the potential for unreported data. For example, it is possible that ongoing programs included in this review collect and plan to publish data pertaining to reach, effectiveness, adoption, implementation, or maintenance in the future; thus, this data may not have been available for this review. In an attempt to fill this gap, this study included data from complementary publications and the first author (KC) searched the program's webpage or inquired with the first author of reviewed studies via email.

Conclusions and future directions

The use of diverse, real-world settings, and practitioners as delivery agents (i.e., practice-based evidence) has been recommended to enhance the scalability of community-based interventions for adults with cancer [8]. Findings from this scoping review suggest that more work is needed, particularly in the areas of reach, adoption, implementation, and system-level maintenance. Based on the findings from this scoping review, organizations and practitioners should consider the following recommendations (1) *Reach*: collect detailed data on reasons for non-enrollment or non-completion, expand eligibility criteria, and recruit underserved cancer types and populations (e.g., racial/ethnic minorities, rural); (2) *Effectiveness*: use measures of QOL with established MCID

values and consider systematically collecting and reporting program evaluation data; (3) *Adoption:* utilize standardized program and instructor training manuals, keep detailed records, and/or collect qualitative information to determine what the contextual factors are that may help or hinder widespread program adoption; (4) *Implementation*: systematically record and report all program procedures and costs (e.g., delivery personnel, training required, sources of funding, and equipment) using a manual of procedures, and track fidelity across cohorts/waves and sites; (4) *Maintenance*: ad hoc plan to collect data at follow-up time points for outcomes of interest, and collect and report information regarding how and what contributes to establishing the program as a convention or norm at the organization or system level.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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