

Effects of the community-based Wellspring Cancer Exercise Program on functional and psychosocial outcomes in cancer survivors

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ABSTRACT

Purpose In this study, we examined the effects of a 30-week community-based exercise program on cancer-related fatigue, quality of life, and other health-related outcomes in a sample of adults with mixed cancer diagnoses.

Methods This prospective cohort study looked at outcomes for participants involved in the Wellspring Cancer Exercise Program in southern Ontario. The program consisted of an initial phase of two supervised sessions weekly for 10 weeks and a transition phase of one supervised session weekly for the subsequent 20 weeks. Outcomes were measured at baseline and every 10 weeks throughout the intervention, as well as at 16 weeks after program completion.

Results During a period of 13 months, 229 of the 355 cancer survivors who enrolled in the exercise program consented to participate in the study. Participants attended 71% of the supervised exercise sessions in the initial phase and 49% in the transition phase. From baseline to the end of the initial phase, significant improvements in cancer-related fatigue, 6-minute walk test, social well-being, systolic blood pressure, balance, and physical activity volume were observed. During the transition phase, health-related quality of life and emotional well-being improved significantly.

Conclusions The Wellspring Cancer Exercise Program is associated with clinically meaningful improvements in cancer-related fatigue and functional aerobic capacity. Several other aspects of well-being in cancer survivors also improved for participants in the program. Community-based cancer exercise programs such as the Wellspring Cancer Exercise Program can improve well-being for cancer survivors and can provide an effective option that enhances sustainability and accessibility to exercise services for this population.

Key Words Exercise, community programs, survivorship, cancer-related fatigue

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INTRODUCTION

In 2016, Canadian estimates placed the number of new cancer diagnoses at approximately 202,400 and cancer-related deaths at 78,800, making cancer one of the most common and deadly chronic diseases in the country¹. Cancer-specific survival rates are improving because of advances in detection and treatment, which has led to an increasing population of survivors, many of whom must cope with persistent or late effects of their disease and associated treatments¹. Accordingly, cancer survivorship—a field defined by a focus on the physical, psychosocial, and economic sequelae of a cancer diagnosis—has emerged and

gained significant clinical and research momentum since the end of the 1980s². Cancer survivorship-related outcomes in research and practice are thus naturally focused on core elements of health-related quality of life, including physical function, emotional well-being, interpersonal relationships, cognitive ability, and spiritual well-being^{3,4}.

Within a comprehensive cancer survivorship model, the role of exercise is a rapidly expanding area of research, with overwhelming evidence showing that exercise confers a variety of benefits, including improved quality and quantity of life⁵. Moreover, cancer survivors consistently report being willing and able to participate in some form of exercise to improve their disease-related outcomes⁶.

Importantly, the evidence across cancer diagnoses, treatments, and exercise interventions demonstrates that exercise is safe, feasible, and effective when appropriately tailored^{5,7}. That research collectively refutes historical dogmas and recommendations that cancer survivors should rest⁷, changing the clinical and public perceptions regarding the relationship between exercise and cancer. Consequently, published evidence-based exercise guidelines now recommend that cancer survivors avoid inactivity and strive to achieve 150 minutes of moderate-to vigorous-intensity exercise weekly^{7,8}.

Knowledge translation in the field of exercise and cancer survivorship has progressed, with major oncology organizations advocating for exercise⁹, and cancer-specific exercise and rehabilitation programs being developed^{10–12}. Studies in growing numbers have elucidated a preference among cancer survivors for exercise services that tailor programs to the individual^{13,14}. Jones and Courneya¹⁴ conducted a survey of exercise preferences in patients with a mixed group of cancers and found that “cancer centres” (54%) are preferred over “at home” (29%) and “community centres” (17%) for exercise counselling (that is, the provision of exercise information and advice). Those preferences might in part be attributable to a sense of clinical familiarity and higher expectations for safety and expertise for exercise recommendations meeting their cancer-related needs. However, a preference for the delivery of exercise programming (that is, exercise-related services such as assessments and intervention) in community fitness centres rather than in cancer centres has been documented^{13,14}, likely because of enhanced convenience and accessibility. Reported preferences for exercise programming are corroborated by observations from coordinators of cancer exercise programs, who report distance, traffic, the high cost of parking or fuel (or both), and difficulty navigating public transit as barriers to facility-based exercise participation—particularly in programs that are delivered in large urban tertiary-care institutions^{10–12}.

It has been reported that cancer survivors want exercise programs to be delivered by practitioners who are trained in both exercise and oncology¹³, providing further support for the development of certifications and training in oncology exercise which will establish credibility for the participants and referral sources for appropriate exercise program design and delivery in the community, potentially quelling questions about safety¹³. Finally, it is worth noting that although the home is a preferred exercise location for cancer survivors¹⁵, conducting appropriate assessments or providing instructions, demonstrations, and information about safety considerations and behaviour change techniques at each participant’s home is often neither pragmatic nor feasible. Such services are therefore likely best delivered in a supervised setting, where cancer-exercise specialists gradually taper supervision to emphasize independent exercise. Given the evidence of benefit, the preferences, and the pragmatic considerations currently known about providing exercise programs to people with cancer, continued engagement in knowledge translation studies that evaluate programmatic approaches is warranted to contribute real-world experiences that will further guide decisions about program development and adaptation.

One knowledge translation strategy is delivery of exercise to cancer survivors through a community-based cancer exercise program whose participants can engage in supervised, tailored exercise sessions with peers and whose program leaders understand the nuances of the disease and treatments, often without the inconveniences of significant travel burden and the psychological association of the hospital with distressing events. Several evaluations of community-based programs have demonstrated improvements in fatigue, physical and social functioning, pain, emotional well-being, and energy in cancer survivors^{10,12,16}. For example, CanWell is a joint initiative between a hospital, a university, and local YMCAs that provides 12 weeks of supervised, facility-based group exercise classes and related education to cancer survivors in Hamilton, Ontario¹⁶. CanWell has demonstrated significant improvements in participant aerobic and functional fitness and in self-reported quality of life¹⁶. An analysis of CanWell participants approximately 2.5 years after their program discharge found that, although most were likely to continue to exercise in the subsequent 12 months, only 47% reported that they no longer needed supervision¹⁵. To optimize long-term exercise independence for cancer survivors, it could be that a more subtle transition to independent exercise through tapering of intervention contact hours might facilitate self-efficacy for independent exercise and appropriate progression. That hypothesis is likely why tapered intervention delivery has been a feature in several recent trials among cancer survivors^{17–20}.

The growing evidence describing benefits and member interest motivated Wellspring, a network of community-based cancer survivorship programs, to develop an exercise program. The Wellspring Cancer Exercise Program (WCEP) delivers community-based exercise programs at several sites in the southern Ontario region. The WCEP provides cancer survivors with 30 weeks of supervised group exercise classes that focus on multimodality exercise delivered in an interval-training format. The purpose of the present study was to examine the effectiveness of the WCEP on physical well-being, cancer-related fatigue, and quality of life over the duration of the program and to examine whether those effects were maintained 16 weeks after program end.

METHODS

Study Design

This prospective multicentre cohort study examined the effects of the WCEP in a mixed population of cancer survivors over time and whether those effects were maintained after program completion. The Research Ethics Board of the University Health Network approved the study, and all participants provided written informed consent before study initiation.

Participants and Recruitment

All participants eligible for the WCEP were eligible to participate in our study. The WCEP accepts individuals who are at least 18 years of age, who have been diagnosed with cancer, who have not previously been enrolled in the WCEP, and who have received a referral and clearance from an

oncologist or family physician to participate in the WCEP. Participants in the WCEP who did not wish to participate in the present research completed the assessments and questionnaires (with the exception of the 16-week post-intervention follow-up) for internal quality control, but their data were not included in the analysis.

Starting in November 2012, newly registered WCEP participants from 4 Wellspring sites in the Greater Toronto and Hamilton areas in Ontario were invited to participate in the study. Recruitment was ongoing until December 2013. To facilitate consistent enrolment, data collection, and intervention delivery methods, the principal investigator (DSM) met with program leaders and administrators to review a standardized approach for all sites and staff. Fidelity was not specifically measured over the course of the study, however. During the meetings, program staff received instruction or reminders about assessment and intervention protocols to ensure procedural standardization across sites according to a program manual.

The Intervention: the WCEP

Wellspring is a Canadian charitable organization that offers a variety of community-based programs, including exercise, to address the needs of cancer survivors. The WCEP is the most accessed program of Wellspring's comprehensive survivorship service offerings and is free of charge for all cancer survivors.

The WCEP is delivered by program leaders who are physiotherapists, kinesiologists, or exercise physiologists who have completed an 8-hour CancerSmart rehabilitation and exercise techniques course provided by experienced program leaders in accordance with an established training curriculum at Wellspring to ensure competency in exercise programming for cancer survivors. Typically, there are 2 program leaders for every 8–10 participants, and clinicians can provide manual therapy (for example, lymphatic massage, lymphedema compression wrapping, kinesio taping), rehabilitation, and education within their professional scope of practice. Each WCEP site has a complement of aerobic exercise equipment (for example, arm ergometers, treadmills, stationary cycles, mini-trampolines, and elliptical machines) and resistance or musculoskeletal training equipment (for example, resistance bands, free weights, stability balls, body bars).

All WCEP participants start their program with an individual assessment conducted by a class leader. The assessment includes a full clinical history of oncologic and non-oncologic concerns, as well as fitness and functional measures that guide the individualized exercise prescription. Participants are then scheduled into a 30-week supervised exercise program that is divided into an initial phase and a transition phase.

The initial phase of the program consists of supervised exercise sessions twice weekly for a period of 10 weeks. The initial phase is designed to introduce, teach, and support basic aerobic and resistance exercises using the principles of interval and circuit training. The transition phase involves once-weekly supervised exercise sessions for a period of 20 weeks; it is intended to transition participants from supervised sessions toward independent exercise (home-based or at another fitness facility) so that

long-term exercise adherence can be maintained. The WCEP thus provides 40 supervised, facility-based sessions over 30 weeks and concurrently encourages participants to exercise independently and to strive for the recommended minimum for cancer survivors of 150 minutes of moderate-to-vigorous physical activity weekly. At the end of the supervised sessions, participants are provided with a discharge package that consists of their fitness results, an exercise log to track future sessions, and an exercise manual with information and instructions that support home-based exercise.

Each group-based exercise session is 60 minutes in duration and includes comparable volumes of aerobic interval training interspersed with musculoskeletal exercises (resistance training, stretching, and balance exercises). Participants are instructed to complete an aerobic station within 50%–80% of their estimated heart rate range (monitored using a pulse oximeter) for 3–5 minutes and to record their post-exercise heart rate into a logbook maintained by the program leaders. Participants subsequently transition to a complementary nonaerobic exercise modality such as one or more of resistance training, stretching, and balance exercises. That cycle repeats 4 to 6 times in a circuit of various aerobic and musculoskeletal exercises. Each exercise prescription is individualized to the baseline fitness level and functional abilities of the participant by a program leader and is routinely reviewed with the participant.

Assessment Timeline

At baseline (T0—that is, program commencement) and at 10 (T1), 20 (T2), and 30 weeks (T3), all WCEP participants complete a standard battery of health-related measures that inform the individualized exercise prescription. Participants who agreed to provide their data for research were invited to complete an additional follow-up assessment at 16 weeks after completion of the WCEP (T4—that is, week 46), resulting in 5 assessments in total. All assessments were conducted at the participant's WCEP home site by a program leader and, for the purposes of this study, occurred within 1 week of the intended assessment date.

Outcome Measurements

Physical, functional, and psychosocial well-being outcomes were assessed by self-report questionnaires and direct measures at each time point.

Cancer-specific fatigue was considered the primary outcome for this study and was assessed using the 13-item Functional Assessment of Cancer Therapy–Fatigue (FACT-F) questionnaire, a well-validated and widely used instrument in cancer and exercise research²¹. The minimal clinically important difference for the FACT-F is 3 points²².

Cancer-specific quality of life was assessed using the 27-item Functional Assessment of Cancer Therapy–General (FACT-G). The FACT-G assesses cancer-specific health-related quality of life in 4 domains, including physical, functional, social, and emotional well-being²³. The FACT-G is an extensively validated cancer-specific measure, with high reliability and internal consistency estimates in several oncologic populations²⁴, including populations in several exercise intervention studies²⁵. The minimal clinically important difference for the FACT-G is 5 points²⁴.

Scores on the FACT-F and FACT-G were arranged such that higher scores were indicative of favourable outcomes. To assess the general health perceptions of the participants, a single item of self-rated health from the Short Form-36 questionnaire in the Medical Outcomes Study was used²⁶. That question asks, “In general, would you say your health is excellent, very good, good, fair, or poor?” The response to this single question has been shown to be well-correlated with general health and significantly contributes to the variance in survival duration beyond objective measures of health²⁷.

The 6-minute walk test (6MWT) was used to assess aerobic functional capacity. It evaluates the ability of an individual to maintain a moderate level of physical activity over a time period reflective of activities of daily living²⁸. The 6MWT has strong test–retest reliability ($r = 0.94$), is positively correlated with submaximal treadmill walking time ($r = 0.78$), is sensitive in detecting age-related declines in physical performance, and discriminates between individuals with high and low physical activity levels²⁸.

Grip strength was used as an indicator of upper extremity musculoskeletal fitness and was assessed using a Jamar Dynamometer (Sammons Preston, Bolingbrook, IL, U.S.A.) according to the Canadian Society for Exercise Physiology protocol²⁹. Grip strength is an independent predictor of mortality in older adults and can potentially identify patients, including those with a high level of function, who are at risk of deteriorating health³⁰.

The Functional Reach Test was used to assess balance; it has relevance with respect to falls and subsequent fractures, for which cancer survivors are at greater risk³¹. The Functional Reach Test is intended for an elderly or functionally limited population and measures the distance that a patient can safely reach forward without falling³². The Functional Reach Test is reliable and has been validated against other functional tasks³².

Body composition was assessed using body mass index and waist circumference according to World Health Organization protocols³³.

Physical activity volume was measured using the Godin Leisure-Time Exercise Questionnaire–Leisure Score Index³⁴. This 3-item measure assesses the frequency of mild, moderate, and strenuous bouts of leisure physical activity. An independent evaluation confirmed its reliability and validity compared with 9 other self-report measures of exercise participation³⁴. It has been widely used with cancer patients and survivors participating in exercise interventions. To capture exercise behaviours that might be related to or facilitated by the WCEP, the Godin Leisure-Time Exercise Questionnaire–Leisure Score Index was modified to ask participants to report their “average weekly exercise over the past month outside of the WCEP.” Data are expressed as total metabolic equivalent of task (MET)–hours per week, whereby time in each of the intensity categories is multiplied by a MET factor of 3, 5, and 9 for mild, moderate, and strenuous physical activity respectively. Data are also expressed as the number of minutes spent in moderate-to-vigorous physical activity weekly, to correspond with the units used in cancer survivor guidelines⁷ [minutes of moderate-to-vigorous physical activity per week = moderate intensity minutes per week + ($2 \times$ vigorous-intensity minutes per week)].

Health history and demographic information for the participants were extracted from their baseline health history. That information included type of cancer, cancer stage, date of cancer diagnosis, treatment history, current medications, age, sex, postal code, vocational status, ethnicity, household income, marital status, smoking status, resting blood pressure, resting heart rate, and score on the Charlson comorbidity index³⁵.

Program Attendance

Program attendance was assessed using the participant training logs completed by the program leader and the participant. The logs indicate the exercise routine on the days that the participant attended the WCEP. Phase-specific attendance was recorded as total sessions attended (out of 20) and percent compliance (number of sessions attended / 20×100). Similarly, total program attendance was recorded as total sessions attended (out of 40) and percent compliance (number of sessions attended / 40×100).

Statistical Analysis

Participant demographics and cancer information are summarized using descriptive statistics (mean $\pm$ standard deviation, or frequencies and percentages). Program effects were assessed in an intention-to-treat analysis that made use of generalized estimating equation (GEE) regression models to estimate the adjusted-sample mean scores of the dependent variables over time and the mean changes between time points. The GEE models included a categorical variable for time points and these covariates: sex, age, cancer diagnosis, attendance (percentage of prescribed supervised sessions attended over both phases), comorbidity score (Charlson comorbidity index), days from diagnosis to WCEP initiation, and treatment status (on or off treatment). Pairwise comparisons between time points were conducted for each dependent variable. Given that most participants were breast cancer survivors (56%), a subgroup analysis using GEE models excluding cancer diagnosis as a covariate was conducted for those participants. For outcome measures in the GEE models, the Markov chain Monte Carlo algorithm was used to impute missing values for variables with an arbitrary pattern of missing data.

All analyses were performed in the R software environment (version 3.2.3: The R Foundation, Vienna, Austria). The R Library geepack was used for fitting the GEE models³⁶. The quasi-likelihood information criterion goodness-of-fit statistic for GEE models was computed using the qicpack (The R Foundation). Pairwise comparisons between time points, together with their standard errors and p values, were made using the lsmeans package (The R Foundation). A p value less than 0.05 was taken to indicate statistical significance.

RESULTS

Participants

Figure 1 presents the CONSORT diagram for study enrolment. During the recruitment period, 355 cancer survivors enrolled in the WCEP, of whom 229 consented to participate in the research study (64.5%). Table 1 sets out the demographic and disease characteristics for the research participants.

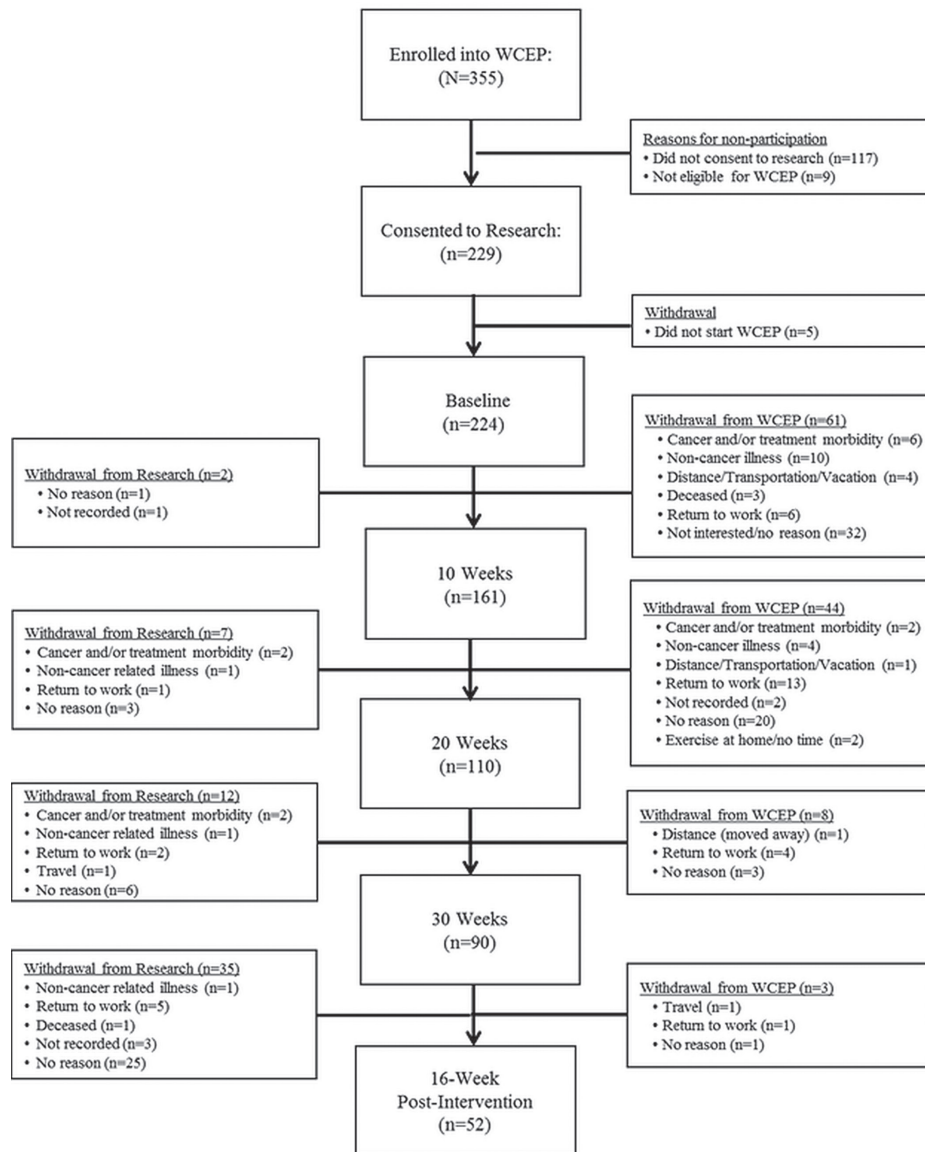


FIGURE 1 CONSORT diagram for study participation. WCEP = Wellspring Cancer Exercise Program.

Briefly, mean age of the participants was 55 years, and the sample was mostly female (82%), white (51%), and married or in a common-law relationship (55%). The most common cancer diagnoses were breast cancer (56%), gynecologic cancer (9%), lymphoma (8%), and colorectal cancer (7%). When starting the WCEP, 44.2% of participants reported being on active treatment; only 9% of participants reported having stage IV cancer. Mean attendance for the supervised sessions was 71% in the 10-week initial phase and 49% during the 20-week transition phase, with a total program attendance of 57%.

Outcomes

Table II presents means with standard error for each outcome over time. From baseline (T0) to the end of the initial phase (T1), statistically significant changes in outcome measures were observed for cancer-related

fatigue [+2.35; 95% confidence interval (CI): 0.18 to 4.52; $p = 0.0258$], social well-being (−1.28; 95% CI: −2.38 to −0.17; $p = 0.0147$), 6MWT (+55.47 m; 95% CI: 30.73 m to 80.22 m; $p < 0.001$), resting heart rate (+2.96 bpm; 95% CI: 0.63 to 5.29 bpm; $p = 0.005$), systolic blood pressure (−4.85 mmHg; 95% CI: −8.33 to −1.38 mmHg; $p = 0.0013$), functional reach (+2.09 cm; 95% CI: 0.02 cm to 4.15 cm; $p = 0.047$), and total MET hours per week (4.46; 95% CI: 0.25 to 8.67; $p = 0.0318$). An increase, but not statistically significant, in total moderate-to-vigorous physical activity minutes was also observed (+47.01; 95% CI: −1.14 to 95.16; $p = 0.06$). During the transition phase (T1–T3), statistically significant changes were observed in health-related quality of life (total score: +4.51; 95% CI: 0.25 to 8.78; $p = 0.0316$) and emotional well-being (+1.61; 95% CI: 0.54 to 2.69; $p = 0.0004$). Functional well-being also increased, but not with statistical significance (+1.54;

TABLE 1 Participant demographics and disease characteristics

Characteristic	Survivor group	
	Overall	BCa subset
Participants (n)	224	126
Mean age (years)	54.9±9.9	53.8±9.0
Sex [n (%) women]	184 (82.1)	125 (99.21)
Ethnicity [n (%)]		
White	114 (50.9)	59 (46.83)
East Asian	17 (7.6)	11 (8.73)
Black ^a	16 (7.1)	12 (9.52)
South Asian	13 (5.8)	8 (6.35)
Other ^b	9 (4.0)	5 (3.97)
Southeast Asian	7 (3.1)	6 (4.76)
Missing	48 (21.4)	25 (19.84)
Smoking [n (%)]		
No	219 (97.8)	124 (98.41)
Yes	2 (0.9)	0 (0)
Missing	3 (1.3)	2 (1.59)
Employment status [n (%)]		
Not working ^c	99 (44.2)	61 (48.41)
Retired	48 (21.4)	21 (16.67)
Other	21 (9.4)	10 (7.94)
Currently working		
Full-time	16 (7.1)	11 (8.73)
Part-time	16 (7.1)	11 (8.73)
Transitioning back to work	14 (6.3)	8 (6.35)
Currently unemployed	9 (4.0)	4 (3.17)
Student	1 (0.4)	0 (0)
Household income [n (%)]		
<\$40,000	21 (9.4)	8 (6.3)
\$40,000–\$80,000	36 (16.1)	27 (21.4)
\$80,000–\$150,000	45 (20.1)	26 (20.6)
>\$150,000	16 (7.1)	11 (8.7)
Missing or prefer not to answer	106 (47.3)	54 (42.9)

95% CI: −0.08 to 3.15; $p = 0.0702$). No other statistically significant changes were observed in any of the other measured variables during the initial or transition phases, or during the 16-week post-intervention follow-up (T4). Figures 2–4 show changes over time for selected outcomes.

Table 1 presents demographic and disease characteristic data solely for breast cancer survivors adjacent to data for the entire sample. Breast cancer survivors were, on average, 54 years of age. Many were white (47%), were married or in common-law relationships (49%), and were receiving treatment during wCEP participation (46%). Breast cancer survivors attended 73% of the supervised sessions during the 10-week initial phase and 47% during the 20-week transition phase, for a total program attendance of 56%. From baseline (T0) to the end of the initial phase (T1), significant changes were observed for the 6MWT (+49.58 m; 95% CI: 17.77 m to 84.40 m; $p < 0.001$). During the transition phase, a statistically significant change was observed in the FACT-G

Marital status [n (%)]		
Married or common-law	124 (55.4)	62 (49.21)
Single, never married	28 (12.5)	27 (13.49)
Separated or divorced	12 (5.4)	8 (6.35)
Widowed	4 (1.8)	4 (3.17)
Missing	56 (25.0)	35 (27.78)
Cancer type [n (%)]		
Breast	126 (56.3)	—
Gynecologic	21 (9.4)	—
Lymphoma	17 (7.6)	—
Colorectal	16 (7.1)	—
Head and neck	13 (5.8)	—
Leukemia	6 (2.7)	—
Myeloma	6 (2.7)	—
Prostate	6 (2.7)	—
Lung	4 (1.8)	—
Skin	3 (1.3)	—
Other ^d	6 (2.7)	—
Cancer stage [n (%)]		
I	43 (19.2)	35 (27.78)
II	51 (22.8)	40 (31.75)
III	48 (21.4)	21 (16.67)
IV	21 (9.4)	7 (5.56)
Missing or unavailable	61 (27.2)	23 (18.25)
Current treatment status [n (%)]		
On treatment	86 (38.4)	58 (46.0)
Off treatment	100 (44.6)	48 (38.1)
Missing or unavailable	38 (17.0)	20 (15.9)
Mean time from diagnosis to initial assessment (days)	580.07±818.57	457.99±453.46

^a Including Afro-Caribbean and African.

^b Middle Eastern, Latino, Hispanic, Ashkenazi Jewish, Aboriginal.

^c Including on disability because of cancer or its treatment.

^d Bladder cancer, leiomyosarcoma, melanoma, pancreatic cancer, renal cancer, stomach cancer.

BCa = breast cancer.

emotional well-being subscale (+1.48; 95% CI: 0.02 to 2.94; $p = 0.046$). No other statistically significant changes were observed during the initial or transition phases, or during the 16-week post-intervention follow-up (T4, data not shown). Figures 2–4 show changes over time for selected outcomes in breast cancer survivors.

DISCUSSION

In response to the mounting randomized controlled trial evidence describing the benefits of exercise for cancer survivors, knowledge translation initiatives are warranted, as are growing advocacy and professional resources to foster more exercise practitioners with oncology expertise. Accordingly, public exercise programs for people with cancer are becoming increasingly prevalent, and their effects are becoming more accessible in the academic literature^{10,11,15,37}.

TABLE II Estimates of outcomes measures from generalized estimating equations^a

Measure	Estimate (mean ± standard error)				
	Baseline (n=224)	10 Weeks (n=157)	20 Weeks (n=77)	30 Weeks (n=86)	16 Weeks after (n=52)
Functional Assessment of Cancer Therapy					
Fatigue	30.83±0.88	33.18±0.98 ^b	33.86±1.14	35.71±1.13 ^c	36.18±1.54 ^d
General					
Health-related QOL (overall score)	72.93±3.34	72.09±3.30	73.23±3.54	76.60±3.58 ^b	79.76±4.05 ^b
Physical well-being (subscore)	20.19±1.12	20.59±1.11	21.05±1.18	21.65±1.21 ^b	23.14±1.31 ^c
Social well-being (subscore)	21.01±1.20	19.74±1.23 ^b	19.48±1.31	20.04±1.31	20.28±1.56
Emotional well-being (subscore)	16.67±0.77	16.50±0.76	16.82±0.81	18.12±0.80 ^{d,e}	18.50±0.91 ^d
Functional well-being (subscore)	15.06±1.07	15.26±1.06	15.87±1.12	16.79±1.13 ^b	17.84±1.30 ^b
Self-rated health	2.47±0.11	2.39±0.13	2.67±0.18	2.82±0.17	2.85±0.21
6-Minute walk test (m)	439.72±23.43	495.19±23.44 ^c	495.40±24.47 ^c	502.85±24.74 ^c	518.79±27.39 ^c
Grip strength (kg)	61.05±4.50	62.50±4.47	62.88±4.60	61.65±4.74	62.54±4.68
Resting heart rate (bpm)	73.34±2.74	76.30±2.89 ^d	77.46±2.80 ^d	76.40±2.98	75.15±3.22
Blood pressure (mmHg)					
Systolic	120.68±3.68	115.83±3.65 ^d	111.18±3.86 ^c	115.34±3.86 ^b	114.82±4.33
Diastolic	78.96±2.69	76.74±2.62	74.81±2.74 ^b	76.43±2.74	79.30±3.36
Body mass index (kg/m ²)	27.98±1.36	27.69±1.36	26.97±1.44	27.46±1.50	26.12±1.53
Waist circumference (cm)	93.07±3.38	92.68±3.29	89.67±3.65	91.69±3.71	90.78±4.08
Functional reach (cm)	33.04±2.06	35.13±2.07 ^b	34.30±2.13	34.22±2.23	36.99±2.21 ^b
Godin Leisure-Time Exercise Questionnaire					
Total weekly MET-hours	14.03±3.55	18.48±3.70 ^b	21.15±4.11	20.84±3.78	18.98±3.89
Total moderate physical activity minutes	118.67±44.28	165.68±47.15	187.34±50.69	206.55±46.88	185.69±48.18

^a Covariates: sex, age, days from diagnosis date to assessment date, percentage program attendance, undergoing treatment, score on the Charlson comorbidity index.

^b $p < 0.05$ compared with baseline.

^c $p < 0.001$ compared with baseline.

^d $p < 0.01$ compared with baseline.

^e $p < 0.001$ comparing 16 weeks after with 30 weeks.

QOL = quality of life; MET = metabolic equivalent of task.

In the present study, we describe the effects of the WCEP, a 30-week community-based exercise program for cancer survivors in southern Ontario. Participants in the program achieved clinically important improvements in fatigue and functional aerobic capacity as measured by the FACT-F and the 6MWT respectively. Both outcomes were improved early in the intervention (within the first 10 weeks) and were maintained or further increased by 16 weeks after program completion.

Those findings echo some of the earliest literature about exercise interventions for people diagnosed with cancer, which focused on those outcomes because of their salience to the survivorship experience³⁸. Cancer-related fatigue is the most common and distressing adverse effect associated with cancer and significantly impairs quality of life³⁹. Additionally, aerobic capacity is significantly reduced—by approximately 30%⁴⁰—in cancer survivors and is a strong predictor of operative complications⁴¹, quality of life⁴², and cancer survival⁴³. Systematic reviews and meta-analyses have established that exercise is safe and can play an important role in managing or improving fatigue and aerobic capacity^{21,44}, outcomes that constituted

the primary rationale for the development of the WCEP and are included in this programmatic evaluation.

Interestingly, we observed an increase in resting heart rate by approximately 3 bpm and 4 bpm from T0 to T1 and to T2 respectively. Although we cannot assert causality in the absence of an experimental design, an increase in resting heart rate is generally considered to be an adverse outcome indicative of declining physical fitness and cardiovascular efficiency. At present, no apparent consensus has been reached on a minimal clinically important difference in resting heart rate, although changes of as few as 3 bpm have been cited (albeit with limited clinical justification⁴⁵). More recent research suggests that clinically important changes occur at ±5 bpm⁴⁶. Vazir and colleagues⁴⁶ demonstrated that an increase of 5 bpm between subsequent visits increased the risk of all-cause or cardiovascular mortality, hospitalization, or heart failure; in contrast, a decrease of 5 bpm was associated with lower risks of the same outcomes in 7599 patients with chronic heart failure. Recent studies on resting heart rate and cancer-specific outcomes failed to demonstrate consistent risk profiles for total cancer or cancer-specific mortality with resting heart rate changes of

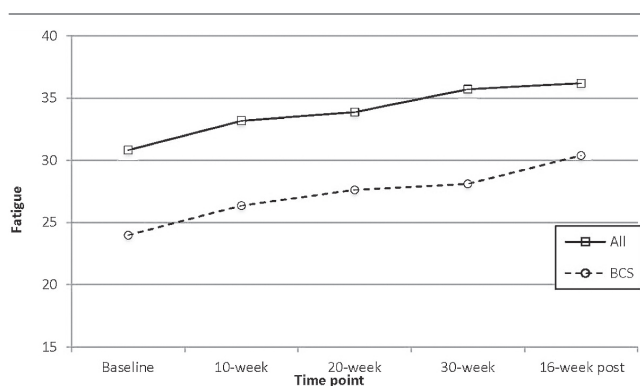


FIGURE 2 Mean score on the Functional Assessment of Cancer Therapy–Fatigue at each time point, for the sample overall and for the breast cancer subset (BCS).

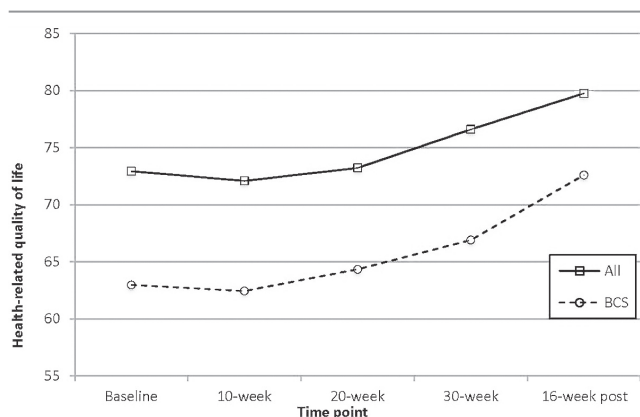


FIGURE 3 Mean score on the Functional Assessment of Cancer Therapy–General at each time point, for the sample overall and for the breast cancer subset (BCS).

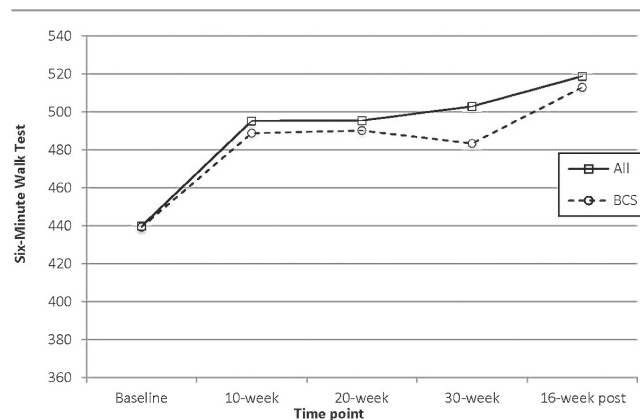


FIGURE 4 Mean 6-minute walk test (metres), for the sample overall and for the breast cancer subset (BCS).

10 bpm^{47,48}. Perhaps more important than change in resting heart rate is the resultant value, because several large studies have observed an increased risk of all-cause and cardiovascular-specific mortality with resting heart rates greater than 80–90 bpm^{49–51}. Given that our current sample demonstrated a mean change of up to 4 bpm to a mean of 77 bpm, the clinical relevance of the finding is questionable.

The WCEP exercise approach focuses on interval training, one of the first exercise approaches shown to successfully mitigate cancer-related deconditioning³⁸. Since the early trials, numerous studies have found that interval training provides benefits for a number of cancer survivors, including those receiving chemotherapy³⁸ or stem-cell transplantation⁵², those with anemia (hemoglobin: 80–110 g/L)⁵³, and those awaiting lung resection for non-small-cell lung cancer⁵⁴. Dimeo *et al.*⁵⁵ examined the effect of an in-hospital interval-training program for patients with a mix of cancers ($n = 70$) undergoing high-dose chemotherapy and autologous peripheral stem-cell transplantation. In that randomized controlled trial, intervention participants were required to engage in cycling on a bed-mounted cycle ergometer at 50% of their age-predicted maximum heart rate for 1 minute 15 times separated by 1-minute rest periods. The authors found that, compared with exercise participants, control participants experienced a 27% decline in physical performance and also a prolonged duration of neutropenia, thrombocytopenia, and hospital length of stay.

Although the benefits of continuous training are well described, interval training might be an ideal training option when working with patients having significant morbidity or deconditioning, because it permits the accumulation of physical activity volume at various intensities, without the strain of continuous exercise. Accordingly, it is recommended for older, deconditioned adults with chronic diseases⁵⁶. For the WCEP, the model is particularly advantageous because it permits consistency in program delivery and yet accommodates the functional and clinical acuity spectrum of the cancer survivors that might attend.

In a study similar to ours, Rajotte *et al.*¹⁰ examined the effects of the Exercise and Thrive program for cancer survivors at YMCAs in the United States. In both studies, survivors with a mix of cancers were engaged in an individualized exercise program within a group setting twice weekly for approximately 3 months (12 weeks plus transition phase for the WCEP vs. 10 weeks for Exercise and Thrive), delivered by trained staff at several centres (13 YMCAs vs. 4 Wellspring sites). The YMCA program featured a 90-minute group class consisting of an aerobic warm-up (10 minutes), resistance training (50 minutes), and 30 minutes of “community building” during which participants could engage in “sharing personal experiences, thoughts, or didactic and experiential training in breathing, relaxation, stress management, nutrition, and complementary treatments.” In the WCEP, participants immediately engaged in the interval training program at enrolment and had access to other survivorship resources at Wellspring outside of the WCEP. The YMCA study found improvement in fatigue (using the Fatigue Symptom Inventory) and the physical and mental component summary scores of the Short Form-36, insomnia, musculoskeletal symptoms, upper and lower body strength, 6MWT, flexibility, mental health, and social support. In both the YMCA study and the present work, body weight did not change; however, significant reductions in systolic blood pressure were found (−4.9 mmHg for the WCEP and approximately −4 mmHg for Exercise and Thrive). Reductions in systolic blood pressure of 2 mmHg are considered clinically meaningful, given that earlier

research has shown that reductions of that magnitude are associated with fewer premature deaths and strokes⁵⁷.

In community-based cancer exercise programs for patients with multiple types of cancers, breast cancer participants commonly constitute about 50% or more of attendees^{10,11,16,37}. Given the high proportion of breast cancer survivors in the WCEP, we conducted a subgroup analysis and found that WCEP class attendance patterns in that group were similar to attendance patterns in the general population. Also, similar improvements were observed in the 6MWT, with trends toward improved fatigue and emotional well-being. In cancer exercise research, patients with breast cancer are the most commonly studied, with convincing data that describe fatigue, physical function, and quality of life improvements with exercise⁵⁸. Moreover, compelling data are emerging related to the survival benefit for breast cancer survivors participating in exercise⁵⁸.

Although the WCEP program was not specifically designed for breast cancer survivors, the essential elements of exercise prescription design were used and individualized to each participant. As Campbell and colleagues⁵⁹ describe, exercise-related principles and components are often poorly reported in trials of exercise for breast cancer, and generic exercise prescriptions might lead to suboptimal outcomes. Although breast cancer survivors were significantly over-represented in the WCEP, there are challenges in detailing disease site-specific exercise adaptations that addressed the heterogeneity of the participants. In the effort to tailor the program, each participant in the WCEP completed an assessment with a cancer exercise specialist (often a physiotherapist or kinesiologist) to define the specific functional needs that were to be addressed with exercise.

The disproportionate representation of women with breast cancer in mixed-cancer exercise programs is poorly understood and runs contrary to what the current literature would suggest. In general, men are more likely to engage in physical activity⁶⁰. Competing responsibilities, such as familial roles or other caregiving, have been suggested as barriers to exercise behaviour for women compared with men^{61,62}. Gender roles and perceptions of unfemininity have also been identified as potentially lessening exercise participation by middle-aged or older women⁶³, the age of many women affected by breast cancer. In cardiac rehabilitation programs, Lieberman *et al.*⁶⁴ found that women were more likely than men to report concomitant illness as a barrier to attending. Similarly, Ottenbacher *et al.*⁶³ observed that, compared with men having prostate cancer, women having breast cancer more frequently cited barriers and the effect of each barrier on exercise behaviour. Nevertheless, our experience of breast cancer prevalence in the WCEP is similar to that in other studies and represents an area requiring further investigation for sex or cancer subgroup differences affecting participation in cancer exercise programs.

Our study has a number of important strengths. First, the WCEP represents a knowledge translation initiative, grounded in evidence of the benefit of exercise for cancer survivors delivered in the community in an accessible and sustainable manner. Consequently, our study has direct ecologic validity and provides a model for other community-based organizations that might want to deliver

exercise services for individuals with chronic disease. The duration of the program is well beyond that of many cancer exercise programs and includes a transition phase that is designed to taper reliance on the community centre and to motivate independent exercise. Our analysis included a 16-week post-intervention follow-up that did not yield any significant changes from the end of the transition phase, suggesting that many of the benefits obtained during the intervention were maintained during that period. An interval training design that has been successful in the earlier literature was used, delivered by exercise specialists trained in exercise for cancer patients. The WCEP was delivered in multiple centres and was accessible to urban and suburban communities alike, providing accessibility to a significant geographic and relatively population-dense region.

However, our study is not without limitations. Cautious interpretation of our results is warranted for several reasons:

- The study has no control group, and thus only correlative inferences can be made.
- No data were available about how many of the participants accessed multiple Wellspring cancer support services, nor about how many WCEP participants received manual therapy in their exercise sessions.
- The study population was composed of a heterogeneous group of cancer survivors.
- No data were collected concerning the reasons for refusal to participate in the research study or the reasons for missed training sessions.

With respect to missed training sessions, information about why participants missed a session would be helpful in understanding whether barriers to participation in facility-based training change over time. In a *post hoc* analysis to explore adherence in “completers” (defined as attending the T3 or T4 assessment, or both), we found that, compared with non-completers, completers had a significantly higher total program adherence rate ($81.5\% \pm 14.7\%$ vs. $39.8\% \pm 26.9\%$, $p < 0.001$). Given that our primary analysis for adherence reflects an intention-to-treat model, it is important to consider that adherence to the WCEP was quite different for those who completed all the assessments, possibly reflecting differing and evolving barriers to class attendance over time.

Cancer exercise programs such as the WCEP are a result of high-quality trials. Such programs represent an important evolution of research that enables the leveraging of existing infrastructure for intervention delivery to generate hypotheses and answer questions about program optimization and innovative strategies to improve access for cancer survivors. Evidence-based guidelines for physical activity after a cancer diagnosis undermine the rationale for conventional randomized controlled trials in which the control group does not receive physical activity recommendations or guidance. The emergence of numerous cancer exercise programs and evaluative studies demonstrating the effectiveness of those programs in improving patient well-being now challenges researchers to pursue questions about referral patterns, subgroup disparities in participation, accessibility challenges and innovations, and clinician advocacy to promote awareness and patient

attendance. Future research in those areas is required to further establish exercise as a viable and sustainable support for people with cancer.

CONCLUSIONS

Convincing literature supports the translation of clinical trial findings into patient care with respect to exercise in the management of cancer. The present study represents the programmatic evaluation of a novel, evidence-based community exercise program that uses an interval and circuit training approach and tapers training volume while motivating independent exercise behaviour for people with cancer. Our findings are consistent with the literature describing improvements in cancer-related fatigue, aerobic capacity, and quality of life with exercise, and yet they are novel in that they add the specificity of some population-specific measures for fatigue and quality of life that have not previously been used in studies of community-based cancer exercise programs.

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CONFLICT OF INTEREST DISCLOSURES

We have read and understood *Current Oncology's* policy on disclosing conflicts of interest, and we declare the following interests: DSM has received fees from Wellspring as a research associate. AB and HB have received fees as Wellspring staff.

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